Using Lesson Study with Preservice Secondary Mathematics Teachers:

Effects on Instruction, Planning, and Efficacy to Teach Mathematics

by

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A Dissertation Presented in Partial Fulfillment
of the Requirements for the Degree
Doctor of Education

Approved March 2013 by the
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ARIZONA STATE UNIVERSITY

May 2013

ABSTRACT

There is a continuing emphasis in the United States to improve student's mathematical abilities and one approach is to better prepare teachers. This study investigated the effects of using lesson study with preservice secondary mathematics teachers to improve their proficiency at planning and implementing instruction. The participants were students (preservice teachers) in an undergraduate teacher preparation program at a private university who were enrolled in a mathematics methods course for secondary math teachers. This project used lesson study to engage preservice teachers in collaboratively creating lessons, field testing them, using feedback to revise the lessons, and re-teaching the revised lesson. The preservice teachers worked through multiple cycles of the process in their secondary math methods class receiving feedback from their peers and instructor prior to teaching the lessons in their field experience (practicum). A mixed methods approach was implemented to investigate the preservice teacher's abilities to plan and implement instruction as well as their efficacy for teaching. Data were collected from surveys, video analysis, student reflections, and semi-structured interviews.

The findings from this study indicate that lesson study for preservice teachers was an effective means of teacher education. Lesson study positively impacted the preservice teachers' ability to plan and teach mathematical lessons more effectively. The preservice teachers successfully transitioned from teaching in the methods classroom to their field experience classroom during this innovation. Further, the efficacy of the preservice teachers to teach secondary mathematics increased based on this innovation. Further action research cycles of lesson study with preservice teachers are recommended.

DEDICATION

This dissertation is dedicated to my Heavenly Father. You are the center of my life and my savior Jesus. I also want to dedicate this to my earthly father who passed away during this doctoral program on June 9, 2012. I miss you Dad and I know I will see you again.

ACKNOWLEDGMENTS

This degree and dissertation could not have been done without the help of so many people in my life.

First and foremost I want to thank Dr. Ron Zambo for being my chair and helping me through the past two years of this process. You put up with my many emails of questions on a daily basis. You spent countless hours revising my writing. I have the highest regard for you as a researcher, but more so as a person.

Second, I would like to thank Dr. Sherman Elliott. You have been very positive with me in your comments during this process. I enjoyed talking with you about this in our offices. Although I am glad you got promoted, I wish you were still there in the office to talk to me.

Third, I want to thank Dr. Tom Heck. You have been very supportive of me and my quest to finish this dissertation. Your experience and comments during our LSC meetings have been invaluable.

Fourth, I want to thank Amy Spilde (soon to be Dr. Amy Spilde) for being my partner during this process. You were always there to give me advice, revisions, and support when I needed it. Most of all, you are a trusted and loyal friend.

Fifth, I want to thank my family. My dad was there for the first two years of this process with me. I enjoyed watching you dad while I worked on homework or wrote my many papers. To my mom I will say that I will not get a raise after this, but I know it was still worth it.

Sixth, I want to thank all of my great teachers from this program. I have learned so much from each of you. I enjoyed my classes here and respect the hard work and

dedication you put into this program. Special thanks to Dr. Debby Zambo who is an awesome leader of this program.

Seventh, I would like to thank all of my co-workers at GCU in the office for putting up with me. I am sure I have gotten on your nerves at times talking about this process but your friendships and support are much appreciated.

Eighth, I want to thank all of the members of my cohort. I am glad I was able to go through this process with each of you. We will all be doctors soon.

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INTRODUCTION

The purpose of the Third International Mathematics and Science Study (TIMSS) in 1995 was to better understand the processes of classroom instruction across different cultures to improve student learning in our schools (OERI, 1996). Since the TIMSS report detailed the success of Japanese students, many researchers have investigated the practice of mathematics teachers in Japan (Geist, 2000; Lewis & Tsuchida, 1998; Stigler & Hiebert, 1999; Tolle, 2010). In addition to student achievement data, the TIMMS report included a comparison of instructional methods used in the United States (U.S.) to those used in Japan. Teaching mathematics in Japan has changed drastically in the past fifty years, while teaching mathematics in the United States has changed very little over the same time period (Stigler & Hiebert, 1999). Results showed that teachers in Japan treated their students, who achieve at a higher level than U.S. students, more like young mathematicians compared to teachers in the U.S. Mathematics teachers in Japan focused more on conceptual understanding of mathematics; whereas, the tradition in U.S. mathematics classrooms is to treat the learning of mathematics as memorization and practice (Geist, 2000; Stigler & Hiebert, 1999).

What might account for these differences? Some research indicates that lesson study has resulted in much of the change in Japanese classrooms (Lewis & Tsuchida, 1998; Stigler & Hiebert, 1999). Lesson study is a process to improve students' learning through improved instruction (Curcio, 2002; Fernandez &Yoshida, 2004; Lewis 2002; Stigler & Hiebert, 1999). It is a teacher-led professional development that brings teachers and other educators together to study in-depth the teaching and learning of a

particular mathematical concept or process (Tolle, 2010). The spirit of lesson study involves "collaborating with fellow teachers to plan, observe, and reflect on lessons" (Takahashi & Yoshida, 2004, p. 439).

Lesson study focuses on successful teaching and learning over time using a systematic method of refining lessons through planning collaboratively, implementing the plan, testing the plan with students, and revising the plan based on the feedback (McMahon & Hines, 2008; Stigler & Hiebert, 1999). Lesson study was first introduced to American educators by Catherine C. Lewis and Ineko Tsuchida in their article "A Lesson Is like a Swiftly Flowing River" (1998) and later by James W. Stigler and James Hiebert in their book *The Teaching Gap* (1999). Since that time, lesson study has been implemented in schools across the United States and is finding its way into preservice teacher education.

Description of the Problem

Preparing effective teachers of mathematics is one of the most urgent problems facing those in teacher education (Hiebert, Morris, Berk, & Jansen, 2007; Morris, Hiebert, & Spitzer, 2009). Teaching is very complex work, yet some novices presume it to be easy (Grossman, Compton, Ingra, Ronfeldt, Shahan & Williamson, 2009). In fact, many preservice teachers believe that teaching is mostly common sense and professional study is not needed (Ball & Cohen, 1999; Kennedy, 1999; Munby, Russell, & Martin, 2001). The challenge for teacher educators is to provide preservice teachers opportunities to develop habits of continued professional learning (Chassels & Melville, 2009; Ganesh & Matteson, 2010; Hiebert et al., 2007). Planning and teaching lessons can be overwhelming for preservice teachers in the early stages of their teacher education

(Carrier, 2011). Therefore, providing opportunities to learn by doing with careful coaching by experts in low-risk settings is critical to begin learning their practice (Schon, 1987). The university education classroom can provide practice for preservice teachers under less stressful conditions through role-plays and practice teaching in an environment of support and feedback (Fernandez, 2005; Ganesh & Matteson, 2010; Grossman et al., 2009).

Unfortunately, methods courses in university settings can seem far removed from the reality of an actual classroom (Cohan & Honigsfeld, 2006; Grossman et al., 2009). They are typically taught through lectures and discussion of theory and research, but are often not focused on the actual practice of teaching (Fernandez, 2005). Providing multiple learning opportunities and a considerable amount of practice with support from mentors and their peers can serve a great value for preservice teachers (Bowman & McCormick, 2000; Chassels & Melville, 2009; Morris et al., 2009; Tobin, Roth & Zimmerman, 2001). Further, preservice teachers often do not see the connection between their methods courses and their field-experience (Darling-Hammond, 2006b, Lampert & Ball, 1999). Teaching practices in field placements typically are traditional (teacher-centered) and authoritarian and fail to provide models of a standards-based approach (Post & Varoz, 2008). Much of the knowledge needed to teach effectively "is situated in practice, [and] it must be learned in practice" (Ball & Cohen, 1999, p. 3-4).

My View of the Problem

One major problem I have encountered in teaching my secondary math methods class the past few years is that my preservice teachers did not always have multiple opportunities to plan and teach math lessons in my class and their field experience. I

typically have allowed them to plan and teach only one or two mini-lessons in class for the entire semester. Most of the class was centered on me teaching and modeling pedagogical-content strategies for mathematics instruction. However, I have always felt that I was not providing enough practice teaching opportunities for my preservice teachers to be more confident going into their student teaching experience the semester following this class.

Another problem I have had teaching this class in the past is that I did not have any control over what my preservice teachers have done in their field experience classrooms. They were required to observe a secondary mathematics classroom of their choice for 15 hours during the semester. They would choose the school and teacher to observe, so there was no connection to our methods classroom. The preservice teachers would typically just sit in the back of these secondary mathematics classrooms and observe the teacher instruct as they took notes. This did not provide any real practice for the preservice teachers in a classroom setting that would serve as a bridge to their student teaching.

Purpose of the Study

Teacher education programs need to be designed to help preservice teachers develop the ability to learn from teaching that will enable them to grow beyond their university experience (Darling-Hammond & Hammerness, 2005). Some research contends that using lesson study where the preservice teachers themselves are able to reflect and revise actual lessons in a collaborative environment might enhance teacher education programs (Hiebert & Stigler, 1999; Hiebert, et al., 2007). Lesson study has been viewed as a valuable form of pedagogy for preservice teacher education if

implemented properly (Chassels & Melville, 2009; Sims & Walsh, 2008). Introducing preservice teachers to some aspects of lesson study will serve as a valuable step in preparing them to incorporate collaborative planning, reflection, lesson critique, and revision in their future teaching careers (Carrier, 2011). Lesson study will allow preservice teachers to focus on improving their teaching through collaborative lesson planning, multiple teaching opportunities, structured feedback, lesson revisions, and re-teaching (Cohan & Honigsfeld, 2006; Post & Varoz, 2008; Takahashi & Yoshida, 2004; Tolle, 2010).

In addition, there is evidence that incorporating lesson study in methods classrooms that directly link to the field experience has benefitted preservice teachers (Carrier, 2011; Chassels & Melville, 2009; Sims & Walsh, 2008). In fact, preservice teachers report being most influenced by their field experiences due to the connection between their coursework and fieldwork (Darling-Hammond, 2006b; Feiman-Nemser, 1983; Lampert & Ball, 1999; Tabachnik, Popkewitz, & Zeichner, 1979-1980). Programs that integrate coursework and field experience are characterized by a "pedagogy of investigation" which allows preservice teachers to experience some of the realities of teaching through real practice (Ball & Cohen, 1999, p. 13). In conclusion, pedagogy that is gradually integrated into the field experience allows preservice teachers the opportunity to learn from actual teaching rather than theory (Sims & Walsh, 2008).

This study attempted to bridge the gap for preservice secondary mathematics teachers from a university methods classroom to teaching in their field experience through the use of lesson study. As I led the preservice teachers through this fourteen week innovation, I investigated the following questions:

1. How and to what extent does lesson study influence instructional planning by preservice secondary mathematics teachers?
2. How and to what extent does lesson study influence the instructional effectiveness of preservice secondary mathematics teachers?
3. How and to what extent does lesson study influence the teacher efficacy of preservice secondary mathematics teachers?

Chapter 2

REVIEW OF SUPPORTING SCHOLARSHIP

This chapter focuses on the major aspects of the lesson study process including the recent research that has emerged on lesson study for preservice teachers. The steps in the theoretical lens of Vygotsky Space are also outlined in this chapter.

Content-Pedagogy Knowledge

The goal of a secondary methods course should be to help preservice teachers integrate content knowledge, pedagogical knowledge, and pedagogical content knowledge so they can develop into expert teachers (Ganesh & Matteson, 2010; Shulman, 1986). Preservice teachers preparing to be secondary education mathematics teachers take coursework in mathematics and in pedagogy. The primary focus of the methods courses is to help preservice teachers integrate content and pedagogical knowledge as they develop their pedagogical content knowledge for mathematics – that is, the skills, procedures, and competencies needed for teaching mathematics (Shulman, 1986). Many aspects of pedagogical-content knowledge have been identified such as: knowledge of student thinking and teaching strategies (Graeber, 1999; Marks, 1990; Van der Valk & Broekman, 1999), texts and materials (Marks, 1990), and what makes a topic easy or difficult (Henningsen & Stein, 1997; Shulman, 1986). Taking critical components of a mathematical topic and deconstructing them to make them accessible for students is a critical aspect of pedagogical-content knowledge that preservice teachers need many opportunities to develop (Ball, 2000; Hiebert, et al., 2007).

One of the specific advantages of lesson study is that it broadens the pedagogical-content knowledge of the preservice teachers (Sibbald, 2009). Some contend this is due

to the authenticity of being situated in a classroom setting while in the midst of a teacher's practice (Wagner, 2003). This provides a "reflective immediacy" that many teachers find beneficial (Shulman, 2003, p. 9). The lesson revisions and debriefing discussions after a lesson can impact classroom practice immediately, which makes it popular with many practicing teachers (Hartman, 2004). However, the specific aspect of the lesson study process that improves teaching is not yet fully understood due to the majority of the research being from small sample sizes in local settings (Lewis, Perry, & Murata, 2006; Wagner, 2003).

Lesson Study for Preservice Teachers

Although most of the research on lesson study focuses on practicing teachers, there is some recent evidence that adapted versions of lesson study can be used effectively with preservice teachers (Carrier, 2011; Chassels & Melville, 2009; Cohan & Honigsfeld, 2006; Fernandez, 2005; Ganesh & Matteson, 2010; McMahon & Hines, 2008; Post & Varoz, 2008; Sims & Walsh, 2008). The core of lesson study is bringing teachers together to carry out the process of planning a lesson, teaching the lesson with the lesson study team observing, and then examining the lesson during a debriefing session (Yoshida, 2008). For preservice teachers, lesson study provides them the opportunity to build professional learning communities, deepen their understanding of content and pedagogy, and develop habits of critical observation, analysis, and feedback (Chassels & Melville, 2009; Chokshi & Fernandez, 2005; Groth, 2011; Tolle, 2010).

Recent research using lesson study with preservice teachers indicates several benefits, but not without some challenges and limitations (Carrier, 2011; Chassels & Melville, 2009; Fernandez, 2005; Ganesh & Matteson, 2010; Sims & Walsh, 2008).

Allowing preservice teachers to re-teach lessons after feedback and revisions was found to benefit preservice teachers because their lessons became more student-centered (Fernandez, 2005), and the feedback from their peers and instructor assisted their development and refinement of their teaching skills (Chassels & Melville, 2009; Ganesh & Matteson, 2010). In fact, preservice teachers showed a heightened understanding of their students as well as an appreciation for the insights that their colleagues provided after participating in lesson study (Chassels & Melville, 2009). Further, the benefits of collaboration with their peers when planning lessons showed an increase in confidence in the effectiveness of their lessons, as well as more openness to different teaching and learning styles (Carrier, 2011; Chassels & Melville, 2009; Ganesh & Matteson, 2010; Post & Varoz, 2008). In conclusion, not only were teaching strategies for preservice teachers enhanced by lesson study, but also a deeper understanding of their subject matter knowledge was developed (Chassels & Melville, 2009; Fernandez, 2005; Ganesh & Matteson; 2010).

The opportunity to observe lessons from classmates provided preservice teachers enhanced skill in critiquing lessons as well as exploring effective and ineffective teaching strategies (Chassels & Melville, 2009). The benefits of lesson analysis and revision will benefit them as they enter student teaching and transition to their own classrooms in the future (Carrier, 2011). A critical aspect of lesson study with preservice teachers is the knowledge that their lessons improve from observation and feedback that will allow them to accept and learn from constructive criticism (Sims & Walsh, 2008). Also, the impact of lesson study in preservice methods classes was found to positively impact the delivery of lessons in field experience teaching (Chassels & Melville, 2009; Ganesh & Matteson,

2010). More importantly, lesson study can serve as a bridge between the methods classroom and field experience when they are properly linked together (Carrier, 2011).

On the other hand, implementing lesson study with preservice teachers did not come without some problems for the preservice teachers and their instructors. The use of collaborative lesson study teams seems to be the focal point of some issues with lesson study with preservice teachers. Finding the time to collaborate was the primary challenge due to school and work schedules (Carrier, 2011; Chassels & Melville, 2009). When it came to linking the methods classroom to the field experience, a prevalent issue was dealing with the logistics and coordination of scheduling in the schools that preservice teachers did their field experience teaching. Many schools and teachers did not understand the process of lesson study, and therefore did not provide the necessary time for debriefing (Chassels & Melville, 2009). In conclusion, finding common times for the preservice teachers to meet to plan their lessons and teach in their field experience was not always feasible, and therefore adaptations to the lesson study process were typically necessary (Carrier, 2011; Chassels & Melville, 2009; McMahon & Hines, 2008).

Lesson Study Planning

Lessons that are carefully planned improve teaching due to a detailed analysis of how each feature of the lesson will work together (Hiebert & Stigler, 2000). Planning collaboratively through lesson study has shown to increase the sophistication of lesson details (Stewart & Brednefur, 2005). Some research using lesson study points to the use of a four-column lesson plan adapted from Japanese lesson study (see Figure 1) that uses both vertical and horizontal dimensions that are synchronized based on sequential order (Lewis, 2002; Mathews, Hlas, & Finken, 2009). A typical four-column lesson plan

requires predicting student responses, preparing appropriate teacher responses (such as further questioning, differentiation, and scaffolding), and assessing students' understanding (Mathews et al., 2009).

A major advantage of the four-column lesson plan model is that it can help preservice teachers become more adept at predicting and supporting student reasoning, which will provide a more student-centered approach to their teaching (Hiebert et al., 2007; Mathews et. al., 2009; Sims & Walsh, 2008). Contemplating student responses and possible questions that might occur ahead of time helped preservice teachers feel more confident when teaching (Sims & Walsh, 2008). The traditional lesson plan format in the United States consists of one column, is sequential, and is focused on teacher actions. On the other hand, the four-column lesson plan model focuses more on seeing the lesson from the students' point of view (Hiebert et al., 2007; Lewis, 2002; Mathews et al., 2009; Sims & Walsh, 2008).

Overall Goal:

Materials Needed:

Steps of the Lesson: Learning Activities and Key Questions	Expected Student Reactions or Responses	Teacher's Response to Student Reactions/Things to Remember	Goals and Method(s) of Evaluation

Figure 1. Four column lesson plan template. Adapted from Mathews, M., Hlas, C., & Finken, T. (2009). Using lesson study and four-column lesson planning with preservice teachers. *Mathematics Teacher*, *102*(7), p. 506.

Lesson Study Debriefing

The post-lesson discussion is at the heart of the entire lesson study process and clearly benefits inservice and preservice teachers (Choksi & Fernandez, 2004; Cohan & Honigsfeld, 2006; Groth, 2011; Tolle, 2010). Lesson study allows for individual teachers and other participants to reflect in the context of the classroom (Schon, 1983). Some key questions that might be asked include: What about the lesson worked well? Could the lesson have been improved? How? What could the teacher have done differently to improve student learning? The teacher who taught the lesson typically speaks first during the debriefing session, discussing what they think worked and what did not work in the lesson followed by comments, suggestions, or questions by the other participants (Groth, 2011; Stigler & Hiebert, 1999; Tolle, 2010).

Preservice teachers often have difficulty engaging in reflective thinking due to a lack of time and structured opportunities for reflection in their teacher preparation classes (Goodell, 2006). Could the use of lesson study provide the structured reflective environment needed for preservice teachers? Some research seems to be pointing in that direction, but not without some caution. Lesson study can provide the necessary time and opportunity for rich discussion on teaching strategies that is focused on student learning for preservice teachers (Carrier, 2011; Chassels & Melville, 2009; Ganesh & Matteson, 2010; Sims & Walsh, 2008). In fact, research has shown that preservice teachers readily accepted suggestions from their peers and instructor, which in turn, improved the depth of their future lessons (Fernandez, 2005; Ganesh & Matteson, 2010). However, there is some evidence that preservice teachers expressed hurt feelings during debriefing sessions due to criticisms they received from other team members and mentors (Carrier, 2011). In

fact, some research points out that sometimes these lesson critiques are taken personally and the preservice teachers respond in a defensive manner (Sims & Walsh, 2008). In addition, some of the feedback provided during debriefing sessions lacked depth and focused on the feelings of the preservice teacher rather than the lesson (Carrier, 2011).

To combat these tendencies, Sims and Walsh (2008) argue that debriefing sessions with preservice teachers needs more "direct guidance" than with experienced teachers due to their lack of skills in the area of reflection (p. 728). The importance of modeling for preservice teachers how to self-reflect on their own teaching is critical to their development (Loughran, 1996). Sims and Walsh (2008) offer some suggestions for educators to use with when conducting debriefing sessions with preservice teachers. First, the focus of the debriefing session must be on the teaching and not the teacher. Second, every preservice teacher in the collaborative planning team must refer to the lesson as "our" throughout the debriefing session to enhance team building and minimize criticism (p. 729). Third, all comments made about the lesson have to be supported in light of the stated goals and based on what specifically was observed.

Lesson Study for Professional Growth

When lesson study is used as a form of professional development, it has been found to be more effective than typical school professional developments because teachers are focused on the knowledge and skills needed to be successful in their own classrooms (Hiebert & Stigler, 2000; Sibbald, 2009). Not only are teachers learning more about their content and how to teach it, they are learning more about their students' thinking (Stigler & Hiebert, 1999). Some authors are advocating the implementation of lesson study into preservice teacher education programs to allow beginning teachers to

engage in meaningful discussions about teaching (Chassels & Melville, 2009; Cohan & Honigsfeld, 2006). Although many believe that lesson study is about planning and teaching, it is more importantly about the professional growth that preservice teachers experience through collaboration and discussion of instruction (Chassels & Melville, 2009; Groth, 2011; Post & Varoz, 2008; Tolle, 2010). A common misconception is that lesson study improves instruction primarily through improved lesson plans (Lewis, 2002; Wang-Iverson & Yoshida, 2005). Lesson study not only improves lesson plans, it more importantly focuses on making the classroom a place where professional conversations about teaching and learning occur (Takahashi & Yoshida, 2004; Tolle, 2010).

Teachers are on a continuum of professional development in the area of content and pedagogical knowledge as they move from a preservice to a practicing teacher (Berliner, 1994). Lesson study can provide an opportunity for preservice teachers to participate in collaborative inquiry into the teaching process that might allow for them to move further along that continuum (Chassels & Melville, 2009). The strengths and weaknesses of each individual preservice teacher on a lesson study team can enhance the learning of everyone during collaboration as the uncertainty about a lesson can be reduced. As a result, preservice teachers will encounter rich professional learning through lesson study by having multiple opportunities to talk about subject matter, teaching practices, and students' learning (Chassels & Melville, 2009; Cohan & Honigsfeld, 2006; Ganesh & Matteson, 2010).

Lesson Study for Teacher Efficacy

Teacher efficacy has been defined as "the extent to which the teacher believes he or she has the capacity to affect student performance" (Berman, McLaughlin, Bass,

Pauly, & Zellman, 1977, p. 137). Some research describes teacher efficacy as a teacher's belief or conviction that they can influence how well students learn, including those students who might be difficult or not easily motivated (Guskey & Passaro, 1994). Bandura's theory of self-efficacy suggests that efficacy may be most malleable early in learning; therefore some of the most powerful influences on teacher efficacy can be during those early years of teaching or becoming a teacher (Johnson, 2010).

Teacher efficacy has two components: personal efficacy and outcome expectancy. Personal teaching efficacy is defined as a belief in one's ability to teach effectively, and teaching outcome expectancy is the belief that effective teaching will have a positive effect on student learning (Enochs, Smith, & Huinker, 2000). Some teachers expect certain behaviors to result in desirable outcomes (outcome expectancy); they may also believe in their own ability to make that behavior happen (personal efficacy). Those teachers who believe that student learning can be impacted by effective teaching are exhibiting strong outcome expectancy beliefs, and those teachers who have confidence in their own teaching abilities are showing strong personal efficacy beliefs (Enochs et al., 2000).

Many studies indicate that teacher efficacy beliefs may account for differences in individual teacher effectiveness (Armor, Conroy-Osequera, Cox, King, McDonnel, Pascal, Pauley & Zellman, 1976; Berman et al., 1977; Brookover, Schweitzer, Schneider, Beady, Flood, & Wisebaker, 1978). Research on teacher efficacy has shown that behaviors such as persistence on a task, risk taking, and use of innovations are related to degrees of efficacy (Ashton, 1985; Ashton & Webb, 1986). Teachers with high efficacy are resourceful, cause-and-effect thinkers who always persist when things do not go

smoothly or when they face setbacks (Bandura, 1993; Guskey, 1988). Highly efficacious teachers tend to teach in a more student-centered way as compared to those with low efficacy who teach more in a teacher-directed manner (Czerniak, 1990). Further, teachers with high efficacy effectively plan and organize for instruction and implement innovation to meet the needs of their students (Guskey, 1988; Stein & Wang, 1988).

A teacher's development of content knowledge and pedagogy can be a valuable way to increase levels of self-efficacy. This hypothesis is supported through the idea of profound understanding of fundamental mathematics, which states that teachers need rich mathematical knowledge that is connected and focused on the curriculum (Ma, 1999; Swackhamer, Koellner, Basile, & Kimbrough, 2009). In fact, some argue that math teachers need specialized knowledge that goes beyond the common knowledge held by most that do not teach math (Ball, Hill, & Bass, 2005; Hill & Ball, 2004). Content courses or mentoring that show new teachers how to teach the content have been successful in raising preservice teachers' efficacy levels (Swackhamer et al., 2009). A teacher's mathematical content knowledge (how to teach the math) is critical to how well the teacher can take material and make it manageable for their students (Ball et al., 2005).

Evidence shows a strong link between lesson study as professional development and self-efficacy (Sibbald, 2009). Professional developments have the potential to impact teacher efficacy; as teachers gain experience and learn more about their practice and how to implement it, they improve their personal competence in their domain (Hill & Ball, 2004; Zambo & Zambo, 2008). Research suggests that collaboration and support have been linked to higher efficacy for teachers, especially for novice teachers (Chester & Beaudin, 1996; Rosenholtz, 1989; Tschannen-Moran & Woolfolk-Hoy, 2007). One

study found “carefully supervised apprenticeship experiences whereby preservice teachers and ‘master teachers’ engage in reflective dialogue” made the difference even over field experience hours in the field (Maloch, Fine, & Flint, 2003, p. 451). Preservice teacher’s efficacy has been shown to increase from observing specific teaching strategies being modeled, as well as from participating in self-reflection about their teaching (Henson, 2001; Johnson, 2010; Schunk & Zimmerman, 1997).

Theoretical Foundation

This study was based on Vygotsky Space as the theoretical framework (Gallucci, DeVoogt, Van Lare, Yoon, & Boatright, 2010). The Vygotsky Space has four phases that are cyclical rather than linear; a learner can be functioning at any given time in any of the quadrants. This theory represents learning in terms of relationships between collective and individual actions and between public and private settings (Gallucci et al., 2010). Vygotskian notions of development about learning and change focus on the internalization and transformation of cultural tools that occur as individuals participate in social practice. The individual internalizes the social practice, transforms the practice in their context, and eventually externalizes (shares) the practice with others (Gallucci et al., 2010).

The iterative stages of the learning process as proposed by Vygotsky and depicted by Gallucci et al. (2010) include the following:

- Individual *appropriation* of particular ways of thinking through interaction with others
- Individual *transformation* and ownership of that thinking in the context of one’s own work

- *Publication* of new learning through talk or action
- Process whereby those public acts become *conventionalized* in the practice of that individual and/or in the work of others

These distinctions help us to see the ways that new ideas of practice are used by practitioners and eventually transformed and integrated into practice (Gallucci et al., 2010).

Chapter 3

RESEARCH DESIGN

Introduction

Chapter 2 provided a review of the literature and the theoretical lens of Vygotsky Space. This chapter explains the rationale and steps in the innovation followed by the data collection tools and the research methodology that were used in the study.

Setting

This action research study was conducted in a secondary mathematics methods classroom at a private university in the southwestern United States. This university has approximately 6,000 students enrolled on campus. I teach on campus in the College of Education, which has approximately 700 students. The participants (preservice teachers) were undergraduates who were studying secondary education and majoring in mathematics. This course was held in the fall of 2012 on Mondays, Wednesdays, and Fridays from 1:15 pm until 2:20 pm over the 15 week semester.

This methods course is the only mathematics methods course required in the secondary education program at this university. Coupled with the face-to-face class meetings, each preservice teacher was required to participate in 15 hours of field experience in a secondary mathematics classroom. As part of the requirements for this study, each preservice teacher agreed to use my assigned school and teacher for their field experience hours.

Participants

In addition to the six preservice teachers in my fall semester secondary mathematics methods class who chose to participate in the study, there were other

participants. I was both a participant and observer to varying degrees throughout this study, depending on which aspect of the innovation was being implemented (Creswell, 2009; Glaser & Strauss, 1967). The field experience teacher selected to host preservice teachers also played a vital role in this study.

My role as practitioner/researcher. My role in this project was significant because I acted as both the practitioner and as the researcher throughout the study (Gay, Mills, & Airasian, 2009). As the practitioner, I was the instructor of the secondary mathematics methods class. As such, I was responsible for a variety of tasks. I selected the list of 10 Algebra I topics from which each lesson study team chose when teaching the first two rounds of the lesson study process (see Appendix F). I formed the lesson study teams and monitored their progress during the collaborative planning. I also provided feedback on the four-column lesson plans and math plans (the math plan included example problems, handouts, and activities that were used) that the preservice teachers created for their lessons.

When the preservice teachers were teaching lessons in our methods classroom, I acted as an observer and took field notes while the lessons were video recorded. During the debriefing sessions after a preservice teacher's lesson, I took on more of a participant role as I facilitated the comments from the other preservice teachers and gave feedback based on my field notes. Between lesson study rounds, I taught pedagogical strategies as well as modeled lessons in the classroom.

As the researcher in this project, I had multiple responsibilities. First, I introduced the project to the preservice teachers and informed them that their participation was voluntary. Second, I oversaw the implementation of each component of

the methods used for this study. Third, I scored each lesson plan and teaching episode based on my field notes and video analysis. Fourth, I coordinated the schedule with the field experience school and teacher. Finally, at the conclusion of the study I analyzed the quantitative and qualitative data and eventually came to warranted assertions.

Preservice teachers. There were eight preservice teachers in the secondary mathematics methods class; six of them participated in this study. These six preservice teachers were directly involved on a daily basis with the innovation in collaboratively planning their lessons, individually teaching lessons in both the methods and the field experience classrooms, and participating in the weekly reflections, surveys and interviews.

Field experience teacher. I worked in coordination with the mathematics department chair from a local high school who chose to be the field experience teacher for this study. This teacher allowed each preservice teacher to teach Algebra I in their classroom twice for this innovation. I briefed the field experience teacher on the lesson study process beforehand. The field experience teacher also scored each preservice teacher with the Lesson Study Planning and Instructional Rubric for both lessons taught in their classroom.

Innovation Rationale

The setting for higher education is generally far removed from where the professionals will eventually work which can lead to a divide between theory and practice (Grossman et al., 2009). One major challenge for university educators is to bridge the gap that exists between a methods classroom and teaching students in a real school classroom (Grossman et al., 2009). The use of lesson study with preservice

secondary mathematics teachers in this project was the innovation I used to link the math methods classroom with field experience teaching.

Previous action research cycle. The effectiveness of an innovation may be increased several hundredfold through cycles of refinement and testing (Lewis et al., 2006). I conducted a pilot study of this innovation with my secondary mathematics preservice teachers in the fall of 2011. This pilot study informed my rationale for the steps to my current innovation (see Figure 2). That was my first attempt with using lesson study.

Innovation

I placed the preservice teachers into two groups of three for the lesson study process. The weekly outline for the 14 week innovation can be seen in Figure 3. The first week of the innovation included the following: pre-efficacy survey, review of the lesson study process, debriefing ground rules (see Appendix G), introduction to the four-column lesson plan (see Figure 1 in Chapter 2), and discussion of the Lesson Study Planning and Instructional Rubric scoring rubric (see Appendix B). I gave each group the list of 10 Algebra I topics (see Appendix F) to choose from for their first lesson to teach, and they collaboratively planned for it in class. Each lesson study team submitted their four-column lesson plan as well as the entire math plan for their lesson to me for revisions before the first teaching episode. Once the lesson was revised, I randomly chose one preservice teacher from each lesson study team to teach the lesson for the following class. The rest of the class acted as typical high school math students during the instruction of the lessons.

There were two lessons taught each class period on days that the preservice teachers were teaching in our classroom (one from each lesson study team). Each preservice teacher taught for approximately twenty minutes and the debriefing session followed immediately after the lesson. The debriefing session started with the preservice teacher who taught the lesson self-reflecting, followed by the rest of the preservice teachers' comments, suggestions, and questions. I guided this discussion and then gave my own feedback after the preservice teachers. I also video recorded each teaching episode with my flip camera and allowed each preservice teacher to observe and reflect on them in their weekly reflections. Both lesson study teams then collaboratively revised the lessons based on the feedback received before the next class period. I randomly chose two new preservice teachers to teach the revised lessons for the following class meeting. After the second teaching episode, the lessons were again revised for the final time and sent to me. This ended Round 1 of the lesson study. The process for Round 2 of the innovation mirrored Round 1.

Following each round of the lesson study, I took a week of class to teach and model math strategies for the preservice teachers. I modeled some of the same lessons that were previously taught by the preservice teachers to allow for more discussion about the mathematical topics and instructional strategies. We participated in debriefing sessions about my modeled lessons and compared the lesson plans and pedagogy to their lessons. I also directly taught other pedagogical strategies and offered feedback based on the previous week of teaching. My original plan of taking a full week between each lesson study round to continue to teach pedagogical strategies was adjusted slightly due to the scheduling of the field experience teaching. For example, I skipped one week of

my instruction between Round 1 and Round 2 due to scheduling with the field experience school. I made up the time between rounds three and four later in the innovation. Figure 3 gives the exact schedule that was followed for the innovation.

The process for Rounds 3 and 4 of the lesson study process was a bit different because these lessons were assigned by the field experience teacher two weeks in advance of the scheduled teaching. Each lesson study team took a week of class to collaboratively plan their lesson and send it to me for feedback. The following week of class was taken to teach, revise, and re-teach those lessons before going to the field experience classroom. Since these lessons were going to be taught in the field experience classroom, each preservice teacher was given the opportunity to teach in our classroom for practice. Therefore, these lessons were taught three times before teaching them in the field experience classroom. This allowed each preservice teacher to be able to practice-teach the exact lesson they would teach in the field experience classroom. These lessons were also revised multiple times by each lesson study team before teaching them in the field experience classroom.

Each lesson study team went to the field experience school as a team to teach these lessons on their assigned day. There were four Algebra I classes assigned from the field experience teacher. The three preservice teachers each taught one lesson and one preservice teacher taught the extra class. While one preservice teacher was instructing, the other members of the team observed and video recorded the lesson. The video recordings of the lesson were shown in our classroom the following week and the class participated in a debriefing session for each preservice teacher. The field experience teacher scored the lessons based on their observations. I also scored the same lessons

from observing the video recordings. Round 4 of the lesson study consisted of the same procedure as Round 3. A simple model of the lesson study process for the innovation is provided in Figure 2. (Note: For a more detailed step by step outline of the entire lesson study see Appendix A).

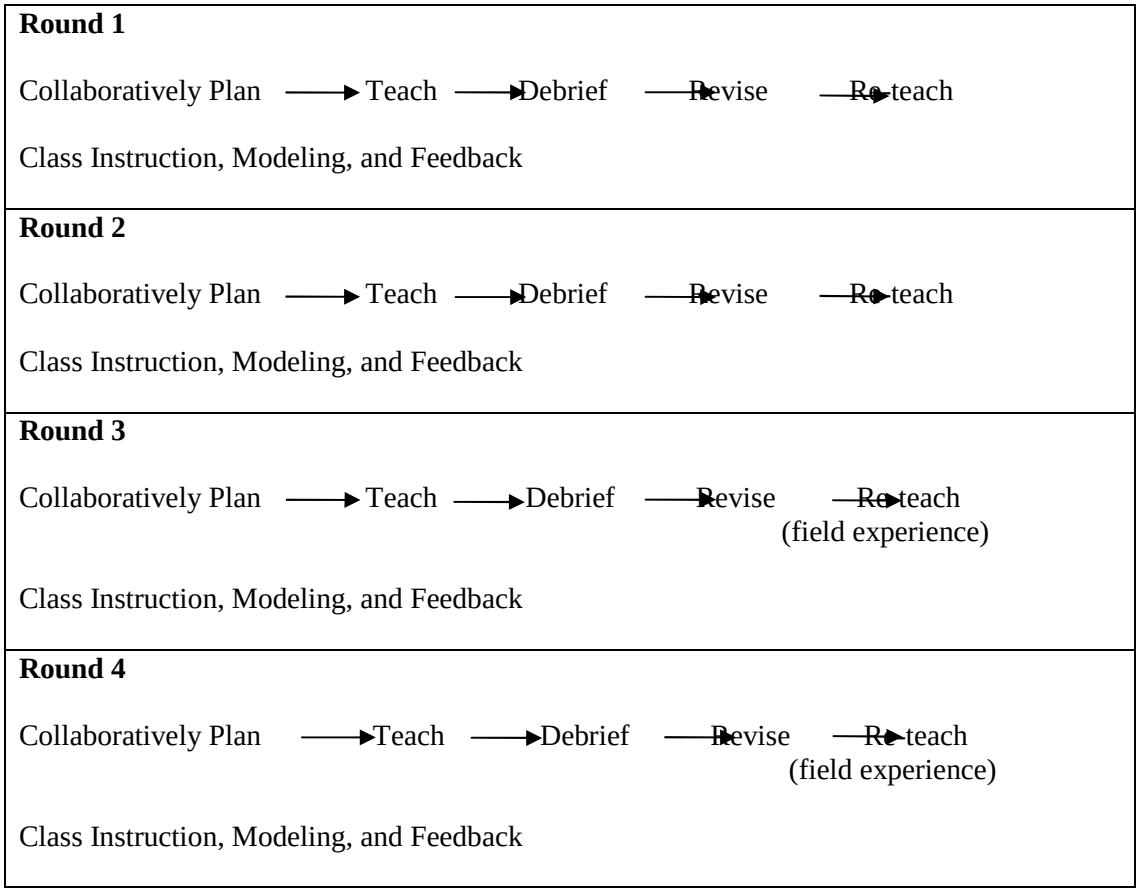

Figure 2. Lesson study innovation model

Innovation Schedule

Figure 3 is the schedule that was followed for the fourteen week innovation.

Some modifications were needed based on scheduling with the field experience school.

Week One	Pre-surveys were given. Introduction to the lesson study process through two articles and debriefing expectations. Introduction to four-column lesson plan and rubric to score teaching episodes.
Week Two (Round 1)	Lesson study teams planned for the first lesson topic and turned in four-column lesson plan and math plan. Lesson study teams collaboratively revised the lessons.
Week Three	Lesson study teams taught lessons for Round 1. Lessons were collaboratively revised and retaught for a second time.
Week Four	Researcher/practitioner taught, modeled, and instructed based on feedback. Preservice teachers began planning for Round 2 of the lesson study.
Week Five (Round 2)	Lesson study teams taught lessons for Round 2. Lessons were collaboratively revised and retaught again.
Week Six (Round 3)	Lessons from field experience teacher collaboratively planned and taught three times in class before teaching in the field experience classroom. Lessons were revised multiple times.
Week Seven	Lessons taught in field experience classroom. Debriefing sessions conducted in class from video recordings.
Week Eight	Researcher/practitioner taught, modeled, and instructed based on class needs and feedback.
Week Nine	Researcher/practitioner taught, modeled, and instructed based on class needs and feedback. Began collaborative planning for Round 4 with lesson assigned from field experience teacher.
Week Ten	Planned for the lesson in field experience classroom for Round 4. This lesson was assigned from the field experience teacher.
Week Eleven (Round 4)	Lessons from field experience teacher taught three times in class before teaching in the field experience classroom. Lessons were revised multiple times.
Week Twelve	Lessons taught in field experience classroom. Debriefing sessions conducted in class from video recordings.
Week Thirteen	Debriefing sessions conducted in class from video recordings. Conducted post-surveys.
Week Fourteen	Preservice teachers interviewed by other professors in the College of Education. Researcher transcribed the interviews.

Figure 3. Innovation Schedule

Vygotsky's Space

The four quadrants outlined in Vygotsky's Space were used as my preservice mathematics teachers transformed new learning into their own daily practice. The following outlines how Vygotsky's Space was used during this study.

Quadrant I – Appropriation: The preservice teachers were introduced to the innovation through the reading and discussion of two research articles about lesson study with preservice teachers. The steps in the process were outlined in class and an example of the four-column lesson plan and math plan were given. I provided guidance during the planning of the first lesson in Round 1 during class and through written feedback on email before the first teaching episode.

Quadrant II – Transformation: Throughout this innovation, I observed the preservice teachers transform their planning from more teacher-centered to student-centered. The four-column lesson plan had one column focused on anticipated questions/problems that students might encounter in this lesson and another column on how to respond to these problems. These columns were the most difficult in the transformation for the preservice teachers from a teacher-centered to a student-centered approach. I also observed the preservice teachers transform a written lesson plan with words to one with actual math examples and activities. A further transformation occurred later in the innovation as each preservice teacher had to learn to take the math plan and implement it by instructing a class of students.

Quadrant III – Publication: This stage was most evident when the preservice teachers had to teach two math lessons in the field experience classroom. It was at this time that they really seemed to focus on making sure their lesson was a refined final product because it would be used in a real math classroom. These lessons were revised

multiple times to make sure they were ready for the field experience teaching. This lesson was their publication of an actual math lesson that had to be implemented in a high school classroom.

Quadrant IV – Conventionalization: This stage was most evident later in the innovation as each preservice teacher gradually began to use their own style of math teaching. Despite having planned the lesson collaboratively, each preservice teacher was allowed to present their lesson in their own way. This allowed for each preservice teacher to conventionalize their own style of instruction as the innovation progressed.

Research Methodology

Action research is any systematic inquiry by teacher-researchers that gathers information about how well their students learn based on an innovation (Mills, 2007). As a university professor who teaches preservice teachers how to teach, I am passionate about improving my practice regarding methods of teaching secondary mathematics. As a former secondary mathematics teacher, I understand the effect that quality mathematics instruction can have on secondary students. Therefore, I used action research to study the effects of using lesson study in my methods classroom with preservice secondary mathematics teachers. I used a mixed-methods approach that examined the impact the innovation had on the planning, instruction, and efficacy of the preservice teachers.

I collected both quantitative and qualitative data using the Convergence Model of Triangulation Design (Creswell & Clark, 2007). The data was collected separately and the results were merged during the analysis stage as shown in Figure 4 (Creswell, 2009). This method was used to strengthen the findings of my study based on using both quantitative and qualitative measures of data collection for each research question

(Creswell, 2009). I understood that my goal was not to come to a conclusion, but rather to find warranted assertions based on my findings (Christensen & Johnson, 2008). My data sources included the Lesson Study Planning and Instructional Rubric, pre-post efficacy survey, Lesson Study Questionnaire, field notes and video analysis of teaching episodes, weekly reflections from the preservice teachers, and semi-structured interviews with all six preservice teachers.

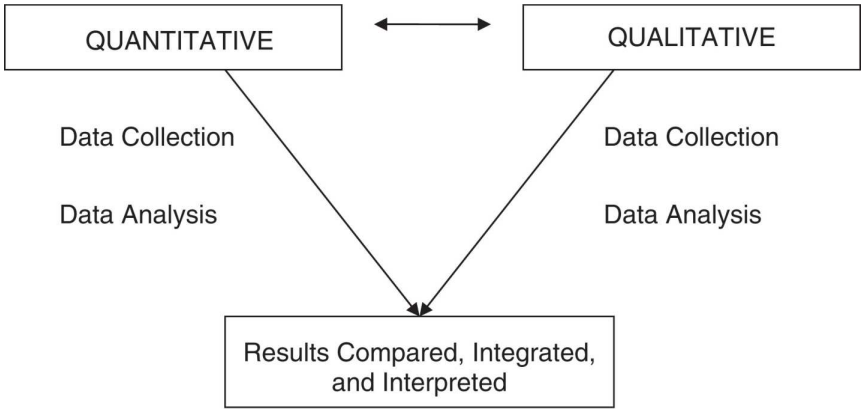

Figure 4. Data collected separately and merged during the analysis stage

Data Collection Tools

The purpose of an exploratory investigation is to develop a clearer understanding of the problem by using the appropriate tools to maximize what conclusions are drawn (Blumer, 1969). Figure 5 lists my research questions and the quantitative and qualitative data collection tools that were used in this study. One goal of a mixed-methods study is to "… offset the weaknesses inherit within one method with the strengths of the other…" (Creswell, 2009, p. 213). The statistical data collected from the quantitative measures

were corroborated with the themes that I constructed from the qualitative data to validate my findings. My hope was to uncover as complete a picture as possible of my study through triangulating the quantitative and qualitative data before coming to assertions about my research questions (Gay, Mills, & Airasian, 2009; Greene, 2007). However, I do not want to "oversimplify" the phenomena in the study, yet still "capture some of the complexity of life." (Corbin & Strauss, 2008, p. 91).

Research Questions and Data Sources	Lesson Study Planning & Instructional Rubric (QUAN)	Efficacy Survey Pre/Post (QUAN)	Lesson Study Questionnaire (QUAN-QUAL)	Field-Notes & Video Analysis (QUAL)	Preservice Teacher Weekly Reflections (QUAL)	Semi-Structured Interviews (QUAL)
1. How and to what extent does lesson study influence instructional planning by preservice secondary mathematics teachers?	X		X		X	X
2. How and to what extent does lesson study influence the instructional effectiveness of preservice secondary mathematics teachers?	X			X	X	X
3. How and to what extent does lesson study influence the teacher efficacy of preservice secondary mathematics teachers?		X			X	X

Figure 5. Relationship between the data measures and research questions

Lesson Study Planning and Instructional Rubric. Teacher quality has been identified by many as the single most important school-related factor tied to increasing

student achievement (Haycock, 1998; Rivkin, Hanushek, & Kain, 2001; Sanders & Horn, 1998). Effective teachers produced six times the learning gains as less effective teachers (Sanders & Horn, 1998). Even though this research is about practicing teachers, I wanted my preservice mathematics teachers to be held accountable for their planning and instruction in our secondary mathematics methods classroom and field experience so they would be more prepared for their student teaching and careers as secondary mathematics teachers. Therefore, I took some of the performance standards used at my university for student teachers and adapted them to create a rubric to score their lesson planning and instruction. This allowed the preservice teachers participating in this study to be familiar with some of the criteria they would be held accountable for during their student teaching placement as well as provided me a standard to measure their progress. I made appropriate changes to the student teaching rubric in order to align with the goals of this research project on lesson study.

I used 10 indicators from the student teaching rubric to create the Lesson Study Planning and Instructional Rubric (see Appendix B). I divided the rubric into three constructs: planning, content-knowledge, and instructional strategies. The planning category has three criteria that include (1) sequencing, (2) using multiple representations, and (3) student-centered planning. The content-knowledge category has five criteria which are (1) understanding the content, (2) connecting concepts, (3) content-pedagogy (how to teach the math), (4) use of resources and technology, and (5) providing appropriate practice. The two criteria on instructional strategies are (1) student engagement and (2) questioning strategies.

The scale for each indicator goes from a 1 – 4 rating. The following demonstrates the rating scale used:

4: *Distinguished:* The preservice teacher consistently exceeds expectations at this stage of their placement;

3: *Proficient:* The preservice teacher meets and sometimes exceeds expectations at this stage of their placement;

2: *Basic:* The preservice teacher minimally meets the expectations at this stage in their placement;

1: *Unsatisfactory:* The preservice teacher does not meet the expectations of the criteria at this stage in their placement.

Piloting the Lesson Study Planning and Instructional Rubric. In order to increase the reliability of this rubric, I followed several steps. First, I had my university professor provide feedback on the rubric. Second, I had another university professor who works with preservice teachers at my university provide feedback and revisions to this rubric. Third, I piloted the rubric with my spring 2012 education classes. The feedback from the preservice teachers provided me with the final version of the Lesson Study Planning and Instructional Rubric after multiple revisions.

Lesson plans with the Lesson Study Planning and Instructional Rubric. Scoring lesson plans with the Lesson Study Planning and Instructional Rubric helped to answer my research question: "How and to what extent does lesson study influence instructional planning by preservice secondary math teachers?" Each four-column lesson plan and math plan for each lesson study team was sent to me for feedback before the first teaching episode and again after each lesson revision. I kept all versions of each on

a file on my computer. The lesson plans were scored based on Questions 1 – 3 from the Lesson Study Planning and Instructional Rubric. There were a total of four scores for each team (one for each round of the lesson study).

Teaching with the Lesson Study Planning and Instructional Rubric. Scoring the instruction with the Lesson Study Planning and Instructional Rubric helped to answer my research question: "How and to what extent lesson does lesson study influence instructional effectiveness by preservice secondary math teachers?" This quantitative data was collected each time a preservice teacher instructed in our class or the field experience classroom. I took field notes and video recorded the lesson each time a preservice teacher taught in the methods classroom. After each lesson, I scored each preservice teacher on Questions 4 – 10 from the Lesson Study Planning and Instructional Rubric. The last two rounds of the lesson study were conducted in the field experience classroom and were video recorded. Those lessons were scored by the field experience teacher in the classroom, and later I scored them after viewing the video recordings. The areas that were measured included the five questions on content knowledge and the two questions on instructional strategies.

Mathematics teacher efficacy survey. The Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) developed by Enochs et al. (2000) was used to collect pre and post data on teacher efficacy (see Appendix D). There are 21 questions on the survey of which 13 are focused on the Personal Mathematics Teaching Belief (PMTE) subscale and eight on Mathematics Teaching Outcome Expectancy (MTOE) subscale. I did change the word "elementary" to "secondary" in two of the questions as my study is working with secondary preservice teachers and this survey was intended for elementary

preservice teachers. All of the other questions fit the purposes of this study as they were written. Each question response offered five options ranging from "Strongly Agree" to "Strongly Disagree." This will help to answer my research question: "How and to what extent does lesson study influence the teacher efficacy of preservice secondary math teachers?"

Piloting the mathematics teacher efficacy survey. To determine the reliability of the survey I used the Statistical Package of Social Sciences (SPSS) to calculate the Cronbach's alpha (Cronbach, 1951). A survey is typically seen as reliable with a score of 0.70 or higher on this test (Cronbach, 1951). The post test results from the pilot study all exceeded the reliability level and are shown in Table 1.

Table 1

Cronbach's Alpha Efficacy Pilot

Factor	Within Factor Items	Coefficient Alpha Estimate of Reliability Post Test
Personal Mathematics Teaching Efficacy Belief (SE)	Items 2, 3, 5, 6, 8, 11, 15 - 21	0.95
Outcome Expectancy (OE)	Items 1, 4, 7, 9, 10, 12 - 14	0.94
Overall Alpha	Items 1-21	0.97

Lesson study questionnaire. I created a lesson study questionnaire in the fall of 2011 that included three constructs that I felt were vital to the lesson study process based on the pilot study (see Appendix C). The three constructs were (1) Collaborative

Planning, (2) Debriefing Sessions, and (3) Lesson Revisions. Each construct had five questions in a Likert scale format along with a section for individual comments after each question. This survey helped to answer my research question: "How and to what extent does lesson study influence instructional planning by preservice secondary math teachers?"

Piloting the lesson study questionnaire. Since this survey did not meet the 0.70 criteria for reliability (Cronbach, 1951) in its original version piloted in the fall of 2011, I made multiple revisions to the survey based on feedback from the preservice teachers and other university professors. First, a qualitative component was added after each Likert question in order to better understand the underlying thinking behind the responses of the preservice teachers. Second, several questions were modified to be more consistent in their language and focus towards each construct. Third, the survey was used during the pilot study and revised one last time before it was used for this study.

Field notes and video analysis. I took field notes during each teaching episode in our methods classroom. These field notes were used to offer feedback during the debriefing sessions for each preservice teacher. For the field experience lessons, I wrote my field notes based on the video recordings that I observed.

Preservice teacher weekly reflections. I had each preservice teacher write weekly reflections throughout the innovation. These reflections typically posed one or two questions to the preservice teachers asking them about the lesson study process or just generally how the innovation was progressing for them. The preservice teachers submitted their responses to the learning management system weekly and I kept them in a file on my computer. This data was used to answer all three of my research questions.

Semi-structured interviews. At the end of the innovation, all six preservice teachers participated in the semi-structured interviews (see Appendix E). This allowed me to gather summative data from each participant in the study. These interviews were conducted by two other professors in the College of Education. I then transcribed the interview data for analysis.

Data Analysis Plan

Based on the Convergence Model of Triangulation from Creswell and Clark (2007), the quantitative and qualitative data were collected and analyzed separately. The data were converged during the interpretation stage to strengthen the conclusions. Researchers often use this model to corroborate quantitative and qualitative findings (Creswell & Clark, 2007).

Quantitative Data Analysis

I analyzed the quantitative data from this study using descriptive and inferential statistics to measure the impact of my innovation (Gay, Mills, & Airasian, 2009). The following section outlines each quantitative data tool and how it was used during the study.

Lesson Study Planning and Instructional Rubric. Using the rubric, I scored each lesson from the two lesson study teams for each of the four rounds. I used the "first attempt" means and "last attempt" means as the scores for each lesson (one lesson for each round). These scores were then compared for each round of lesson study. The 10 indicators from the rubric were used (three on planning and seven on teaching) after each lesson taught in class and in their field experience. The two lessons taught in the field experience classroom were scored by the field experience teacher following the lesson. I

also scored them after viewing the lessons on the video recordings. My final score was the one used in the data comparisons. The data was then entered into a Microsoft Excel spreadsheet and transferred into SPSS. I then used SPSS to compute descriptive statistics and compared mean scores for each round of lesson study for the participants (Gay, Mills, & Airasian, 2009).

Efficacy survey. The six preservice teachers in the study took the efficacy survey as a pre-test and post-test. Another instructor at my university administered this efficacy survey as a pre-test during the first week of class before discussing the innovation, and again at the end of the study as a post-test. I left the classroom during the administration of the surveys so I would not influence the responses. The preservice teachers used pseudonyms to allow for measuring growth from pre to post, yet keeping their surveys anonymous. The data was entered into a Microsoft Excel spreadsheet and then transferred into SPSS to be analyzed. I computed the Cronbach's alpha and the means and standard deviations for the entire survey and for both constructs. I ran a paired samples t-test to determine significance from pre to post of this data.

Lesson study questionnaire. This survey was administered only at the end of the innovation. There was also a qualitative aspect to this instrument. The results of the Likert portion of the questionnaire were entered into a Microsoft Excel spreadsheet and SPSS. I computed descriptive statistics on the quantitative data from this survey using SPSS for means and standard deviations based on each of the three constructs. I also computed the Cronbach's alphas for each of the three constructs as well as for the entire survey of this data to verify the reliability of each construct and the entire instrument.

Qualitative Data Analysis

I used a grounded theory approach to analyze all the qualitative data from this study. Analysis of the qualitative data began with asking questions and comparing the data for commonalities (Corbin & Strauss, 2008, Miles & Huberman, 1994). My hope was to reduce as much of my natural bias as possible through the use of multiple methods and triangulating the data (Greene, 2007), with the goal being to completely understanding the thoughts of the preservice teachers participating in this study while I keep an open mind as to what I might find (Corbin & Strauss, 2008; Miles & Huberman, 1994). The themes that were constructed from the qualitative data were compared with the quantitative data to validate my findings during the analysis stage. Warranted assertions were then presented.

Qualitative data sources. The qualitative data for this study was taken from the Lesson Study Questionnaire, field-notes and video analysis of teaching, preservice teacher reflections, and semi-structured interviews. I analyzed all of the qualitative data through the process of open and axial coding. Themes were eventually constructed (Glaser & Strauss, 1967).

I began with the process of open coding the raw data (Corbin & Strauss, 2008). I started by breaking apart the data into categories based on their dimensions. Then I used axial coding to relate the concepts together. Open coding and axial coding go "hand in hand" according to Corbin and Strauss (2008, p. 198). The open coding came first as I examined the raw data with an open mind to find the underlying meaning from the text (Glaser & Strauss, 1967). This is where I as the researcher tried to clarify what characteristics defined each category and which allowed for new categories or sub-categories to be formed (Glaser & Strauss, 1967). I followed this process of axial coding

and relating the categories to the sub-categories to eventually develop themes based on the data (Glaser & Strauss, 1967; Miles & Huberman, 1994). I also had another doctoral student cross-check each of my qualitative data sets for inter-rater reliability. My final step was to analyze my conclusions with the analysis from the other doctoral student and re-check the data to be sure my final themes clearly represented the data (Glaser & Strauss, 1967).

Chapter 4

ANALYSIS AND RESULTS

In Chapter 3 I described my data collection tools and explained the methodology I used. In this chapter I will outline my data analysis plan and present the results of my quantitative and qualitative data. The first section details how I analyzed my three sources of quantitative data: Lesson Study Planning and Instructional Rubric, pre-post efficacy survey, and the Lesson Study Questionnaire. The results of my analyses follow. The second section explains how I analyzed my four sources of qualitative data: Lesson Study Questionnaire, field notes and video analyses, preservice teacher weekly reflections, and semi-structured interviews. The results of the qualitative analyses are then presented.

Quantitative Data Analysis

Lesson Study Planning and Instructional Rubric. The Lesson Study Planning and Instructional Rubric helped to answer the following research questions: 1) How and to what extent does lesson study influence instructional planning by preservice secondary mathematics teachers? 2) How and to what extent does lesson study influence the instructional effectiveness of preservice secondary mathematics teachers? The rubric consisted of ten questions with three constructs (see Appendix C) each related to the quality of the lesson plan and in regard to planning (Questions 1-3), content knowledge (Questions 4-8), and instructional strategies (Questions 9-10). I scored each preservice teacher on this rubric following their lesson presentation. In Rounds 3 and 4 of the lesson study in which the preservice teachers taught the lesson in their field experience classrooms, I scored the lessons from the video recordings. For scoring purposes, I used

the means of the "first attempt" scores compared to the means of the "last attempt" scores for each lesson plan and teaching episode regardless of which preservice teacher taught the lesson. Every lesson was revised multiple times and re-taught two or three times depending on the available time and scheduling during the innovation.

Reliability of lesson study planning and instructional rubric. Cronbach's alpha was computed for each construct as a measure of reliability. The reliability of each construct exceeded the generally accepted standard of 0.70 (see Table 2).

Table 2

Rubric Cronbach's Alpha

Construct	Item Numbers	Cronbach's Alpha
Planning	Items 1 – 3	0.99
Content Knowledge	Items 4 – 8	0.96
Instructional Strategies	Items 9 – 10	0.96

Analysis of lesson study planning and instructional rubric. Lessons were scored on a four point scale:

4: *Distinguished:* The preservice teacher consistently exceeds expectations at this stage of their placement;

3: *Proficient:* The preservice teacher meets and sometimes exceeds expectations at this stage of their placement;

2: *Basic:* The preservice teacher minimally meets the expectations at this stage in their placement;

1: *Unsatisfactory:* The preservice teacher does not meet the expectations of the criteria at this stage in their placement.

Means and standard deviations for the "first attempt" and "last attempt" rubric scores were compared for each round of the lesson study and for each of the three constructs.

Results from lesson study planning and instructional rubric. The results demonstrate gains from each round of the lesson study to the next (see Table 3). There was growth from each of the means from the "first attempts" of the lesson as the innovation proceeded through each round. In Round 1 the first attempt mean was 2.25 (0.44) compared to 2.35 (0.49) in Round 2. By Rounds 3 and 4 the first attempt lesson plan and teaching had risen to 2.90 (0.31) and 3.20 (0.14), respectively. This same

Table 3

Lesson Study Planning and Instructional Rubric Overall Results

	Round 1	Round 2	Round 3	Round 4
First Attempt	2.25 (.44)	2.35 (.49)	2.90 (.31)	3.20 (.14)
Last Attempt	2.80 (.41)	3.10 (.31)	3.55 (.51)	3.70 (.47)

pattern of growth is also apparent in the means of the "last attempts" as the innovation proceeded through the four rounds. Comparing the first attempt to the last attempt of each lesson also shows growth within each round. For example, in the first round the first attempt went from a 2.25 (0.44) average up to a 2.80 (0.41) average. For Round 2 that comparison from first to last attempt went from 2.35 (0.49) up to 3.10 (0.31). For

Round 3 the initial score was a 2.90 (0.14) and the final score jumped to 3.55 (0.51). The final round of lesson study had a first attempt of 3.20 (.14) as compared to a 3.70 (.47). The patterns of gains are apparent in the graphic representation of the data in Figure 6.

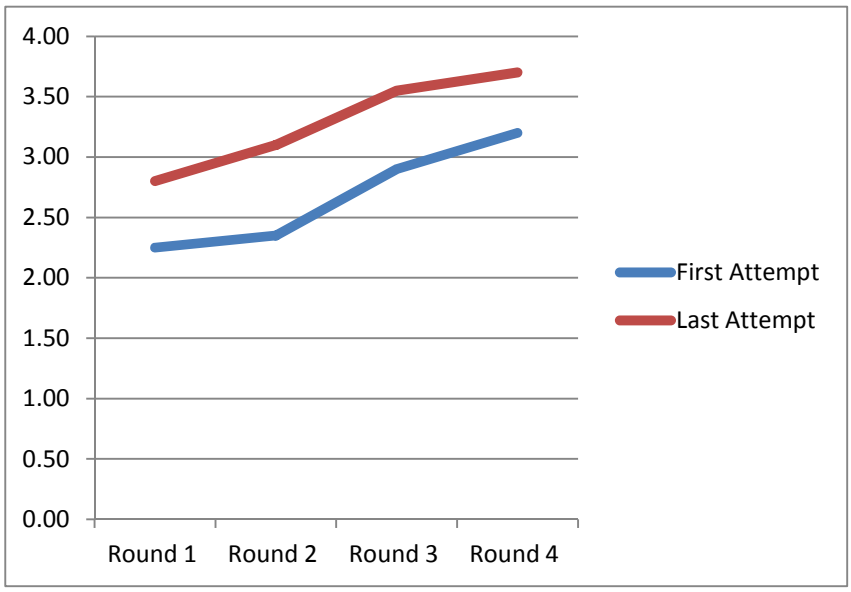

Figure 6. Lesson study planning and instructional rubric comparison

Table 4 displays the results of the means and standard deviations of each of the three constructs of the rubric by each lesson study round. Overall, each of the constructs (planning, content-knowledge, and instructional strategies) showed gains as the innovation progressed through the four rounds.

Table 4

Rubric Construct Means

	Round 1	Round 2	Round 3	Round 4
First Attempt *Planning*	2.33 (0.52)	2.17 (0.41)	2.83 (0.41)	3.00 (0.00)
Last Attempt *Planning*	3.00 (0.00)	3.17 (0.41)	3.83 (0.41)	4.00 (0.00)
First Attempt *Content Knowledge*	2.30 (0.48)	2.40 (0.52)	3.00 (0.00)	3.40 (0.52)
Last Attempt *Content Knowledge*	2.80 (0.42)	3.00 (0.00)	3.60 (0.52)	3.60 (0.52)
First Attempt *Instructional Strategies*	2.00 (0.00)	2.50 (0.58)	2.75 (0.50)	3.00 (0.00)
Last Attempt *Instructional Strategies*	2.50 (0.58)	3.25 (0.50)	3.00 (0.00)	3.50 (0.58)

Efficacy survey. The efficacy survey was administered as a pre-test and post-test to answer the following research question: 1) How and to what extent does lesson study influence the teacher efficacy of preservice secondary mathematics teachers?

Reliability of the efficacy survey. Cronbach's alpha was computed for the entire survey and each construct as a measure of reliability. The reliability of the overall survey exceeded the generally accepted 0.70 standard. The construct on Personal Mathematics Teaching Belief (PMTE) was also above the reliability threshold, but the construct on Mathematics Teaching Outcome Expectancy (MTEO) was not (See Table 5).

Table 5

Final Cronbach's Alpha – Efficacy Survey

Construct	Item #'s	Cronbach's Alpha
Personal Mathematics Teaching Belief (PMTE)	Items 2, 3, 5, 6, 8, 11, 15 - 21	0.90
Mathematics Teaching Outcome Expectancy (MTOE)	Items 1, 4, 7, 9, 10, 12 - 14	0.35
Overall Cronbach's Alpha	Items 1-21	0.80

Analysis of the efficacy survey. To measure the impact of my innovation, I analyzed the efficacy survey using descriptive and inferential statistics (Gay et al., 2009). I calculated the means (*M*) and standard deviations (*SD*) for the entire survey and each construct. A paired samples t-test was then used to compare the pre and post survey results.

Results from the efficacy survey. In regard to Personal Mathematics Teaching Belief, the paired-samples t-test indicated that the preservice teachers showed a significant increase from the pre-test to post-test on personal belief, with means and standard deviations of 3.93 (0.37) and 4.45 (0.28) respectively (t (6) = 4.58, $p < .01$). In regard to Mathematics Teaching Outcome Expectancy, the paired-samples t-test indicated that the preservice teachers also showed a significant increase from the pre-test to post-test on outcome expectancy, with means and standard deviations of 3.38 (0.45) and 3.73 (0.28) respectively (t (1,5) = 3.00, $p < .03$). Both constructs had a less than 5%

probability of occurring by chance. This typically signifies that there is confidence that the innovation itself caused the improvement, not other factors.

Lesson study questionnaire. This questionnaire was given only at the end of the innovation to answer the following research question: 1) How and to what extent does lesson study influence instructional planning by preservice secondary mathematics teachers? The Lesson Study Questionnaire consisted of 15 Likert scale items with qualitative responses following each question (see Appendix C). The 15 questions were broken into three constructs of five questions each. The three constructs were collaborative planning, debriefing, and revising. A five point Likert scale that ranged from "Strongly Agree" to "Strongly Disagree" was used. The qualitative data will be discussed later.

Reliability of the lesson study questionnaire. Cronbach's alpha was computed for each construct and the overall survey as a measure of reliability. The reliability of each construct and the overall survey exceeded the generally accepted standard of 0.70 (see Table 6).

Table 6

Final Cronbach's Alpha – Lesson Study Questionnaire

Construct	Item #'s	Cronbach's Alpha
Planning Collaboratively	Items 1-5	0.77
Debriefing Lessons	Items 6-10	0.96
Revising Lessons	Items 11-15	0.96
Overall Cronbach's Alpha	Items 1-15	0.93

Analysis of the lesson study questionnaire. I analyzed the Lesson Study Questionnaire using descriptive statistics to measure the impact of my innovation (Gay, et al., 2009). I entered the data into an Excel spreadsheet using five points for "Strongly Agree" down to one point for "Strongly Disagree." I then entered the data into SPSS to find the means and standard deviations for each of the three constructs.

Results from the lesson study questionnaire. Each of the three constructs had an average that ranged from "Agree" to "Strongly Agree" that the innovation made a positive impact. The first construct on collaboratively planning had a mean of 4.47 out of 5.0. The second and third constructs of debriefing and revising both had means of 4.80 out of 5.0. However, there was not a pre-test to compare these results with so a measure for significant gains could not be computed.

Qualitative Data Analysis

Data collection instruments. Qualitative data came from four sources: the Lesson Study Questionnaire, field notes and video analysis of the teaching episodes, preservice teachers' weekly reflections, and semi-structured interviews (See Figure 7).

Data Source	Description	Content Coded
Lesson Study Questionnaire	All six preservice teachers took this survey. Most of the answers had qualitative responses after them.	12 double-spaced typed pages
Field Notes and Video Analysis	I took notes for each lesson taught in class and from the video recordings in the field experience.	45 single-spaced handwritten pages
Preservice Teacher Weekly Reflections	Each week all six preservice teachers typed a reflection and emailed them to me on our school learning management system.	47 double-spaced typed pages
Semi-structured interviews	Each preservice teacher was interviewed by two other professors. I transcribed the interviews.	30 double-spaced typed pages

Figure 7. Qualitative data source inventory

Qualitative data analysis began with comparing the data for commonalities (Corbin & Strauss, 2008; Miles & Huberman, 1994). Each of the four data sets were analyzed separately by open coding and then collapsing codes into categories based on similar dimensions (Corbin & Strauss, 2008). Saturation of the data came after multiple attempts of defining and redefining the categories. Eventually themes were created. Another doctoral student analyzed the raw data and independently created themes as a cross-check of my analysis. Considering the results of the cross-check, I finalized the themes for each of the four sets of qualitative data. The themes, theme related components, and assertions presented in each analysis were organized into tables.

Results from the lesson study questionnaire. The Lesson Study Questionnaire was administered to answer the following research question: 1) How and to what extent does lesson study influence instructional planning by preservice secondary mathematics teachers?

The two themes, components from which the themes resulted, and assertions are shown in Figure 8.

Themes	**Theme Related Components**	**Assertions**
Collaborative Planning	Collaborative planning increased the confidence of the preservice teachers. Preservice teachers experienced different ideas/viewpoints about the lessons.	Collaborative planning allowed the preservice teachers to explore other viewpoints and gain confidence in their lesson planning.
Lesson Quality	The debriefing sessions (feedback) improved the lesson quality. The lesson revisions improved the lesson quality.	The preservice teachers' lesson quality improved from the debriefing sessions (feedback) and revising their lessons.

Figure 8. Lesson study questionnaire themes

The first theme that resulted from the Lesson Study Questionnaire was *collaborative planning*. There were two components that led to this theme. The first component was that collaborative planning increased the confidence of the preservice teachers. The second component was that the preservice teachers experienced different ideas/viewpoints about the lessons. One preservice teacher stated the following about collaborative planning, "The group planning activities helped to build my confidence

about lesson planning." Another preservice teacher noted this point about the confidence gained from collaboratively planning, "Overall, my confidence was increased knowing I was on the same page with my peers." One preservice teacher stated the following about the different ideas that the collaborative planning provided, "Members of the group had different ways of teaching or explaining certain things which increased my knowledge of that topic." Another preservice teacher added, "Gaining input from my teammates helped me realize how many different ways a lesson can be taught." These components of the theme *collaborative planning* led to the assertion that collaborative planning allowed the preservice teachers to explore other viewpoints and gain confidence in their lesson planning.

The second theme from the Lesson Study Questionnaire was *lesson quality*. There were two key components that led to this theme. The first component was that the debriefing sessions (feedback) improved the lesson quality. The second component was that the lesson revisions improved the lesson quality. One preservice teacher stated the following about the debriefing sessions, "These sessions forced me to think about what went well or wrong. It was very nice to hear what the others had to say and compare comments/perspectives to mine." Another preservice teacher added, "The debriefing helped me to reflect on the experience, and how I might change the way I present my lessons." One preservice teacher noted a different thought about the debriefing sessions, "…it also made me aware that I was analyzing the others while they were teaching, and I found myself picking certain components and using them in my own teaching." Commenting about the feedback from their instructor during the debriefing sessions one preservice teacher stated, "I especially liked hearing what the instructor agreed with or

would change because to me that tells me whether I am on the right track or not." One preservice teacher stated the following about the lesson revisions, "After making the adjustments, I felt better about the lesson so I was more confident with the teaching." Another preservice teacher added this comment when asked about the lesson revisions, "The process of making a plan, teaching, revising, re-teaching, revising, and teaching again was great in fine-tuning the lesson as well as for my teaching skills." These components of the theme *lesson quality* led to the assertion that the preservice teachers' lesson quality improved from the debriefing sessions (feedback) and revising of their lessons.

Results from the field notes and video recordings. I took field notes during each teaching episode in class and from the video recordings in the field experience classroom to help answer the following research questions: 1) How and to what extent does lesson study influence instructional planning by preservice secondary mathematics teachers? 2) How and to what extent does lesson study influence the instructional effectiveness of preservice secondary mathematics teachers? I used these notes to offer feedback during the debriefing sessions following each teaching episode. The three themes, components from which the themes resulted, and assertions are shown in Figure 9.

Themes	Theme Related Components	Assertions
Teacher-Centered to Student-Centered	Anticipating student misconceptions before the lesson. Shifting the focus from their own actions to the students learning.	Participating in the innovation process helped the preservice teachers move from a teacher-centered approach to a more student-centered approach in their lesson planning and instruction.
Field Experience Increases Focus	The collaborative planning was more refined in preparation for the field experience lessons. The practice-teaching and lesson revisions were more focused in preparation for the field experience lessons.	The collaborative planning, practice-teaching, and revising, improved in preparation for the field experience teaching.
Individual Teaching Style	Preservice teachers explored different ways to teach during their multiple teaching opportunities. The collaboratively-planned lesson was taught differently by each preservice teacher as the innovation progressed.	Each preservice teacher began to have their own distinct style of teaching as the innovation progressed due to more practice teaching.

Figure 9. Field notes themes

The first theme from my field notes and video analysis was *teacher-centered to student-centered*. There were two components that led to this theme. The first component was that the preservice teachers were anticipating student misconceptions before their lessons. The second component was that the preservice teachers began to shift the focus from their own actions to the students learning. Early in the innovation in

Round 1 I wrote in my field notes during a teaching episode that, "…the teacher is focused on themself and is not checking to see if the students understand the material. The lesson does did not account for possible misconceptions that might occur." The transition from teacher-centered to student-centered instruction started to show up in the later rounds of the lesson study. For example, by Round 4 during one lesson observation my notes stated, "…lesson plan accounts for many possible student misconceptions…" Then the lesson itself also demonstrated a shift as the preservice teacher first asked the students to "…predict what might occur next…" in their lesson. I then noted, "…in Round 1 they would have not had the students predict but they would have just told them…" These components of the theme *gradually evolving from teacher-centered to student-centered* led to the assertion that participating in the innovation process helped the preservice teachers make the shift from teacher-centered approach to a more student-centered approach in their lesson planning and instruction.

The second theme from my field notes and video analysis was *field experience increases focus*. There were two key components that led to this theme. The first component was that the collaborative planning was more refined in preparation for the field experience lessons. The second component was that the practice-teaching and lesson revisions were more focused in preparation for the field experience lessons. The evidence confirms that the focus of the lesson planning and instruction improved when the preservice teachers knew they would be teaching this lesson in the field experience classroom. For example, in my field notes in Round 3 before the field experience lesson I have a comment stating, "The lesson study teams are really focused on making their lessons perfect for their field experience teaching. They are seeking my feedback and

continually revising their lesson." In fact, one lesson study team revised their lesson five or six times before they felt it was ready for the field experience classroom. Further, my field notes state, "The preservice teachers are asking for more ideas on how to teach this lesson and make it easy for the students in the field experience to understand." These components of the theme *field experience increases focus* led to the assertion that the collaborative planning, practice-teaching, and revising, improved in preparation for the field experience teaching.

The third theme that emerged from my field notes and video analysis was *individual teaching style*. There were two components that led to this theme. The first component was that the preservice teachers explored different ways to teach the lessons through their multiple teaching opportunities. The second component was that the same lesson planned collaboratively was taught differently by each preservice teacher as the innovation progressed. I allowed each preservice teacher to make minor adjustments to the lesson if they chose when they were instructing or to teach the same lesson in a different way than their teammates. In the beginning rounds of the innovation few variations in teaching style were evident. However, by the later rounds of the innovation there are several examples of individual variations of style for each preservice teacher in my field notes. For example, one preservice teacher showed a video during their lesson about using substitution where none of their teammates had used it. Another example was when a preservice teacher used the analogy of a person introducing their girlfriend to their family and making sure they would shake everyone's hand in the room as a comparison to the distributive property which was not used by the other preservice teachers when they taught this same lesson. The components from the theme *individual*

teaching style led to the assertion that each preservice teacher began to have their own distinct style of teaching as the innovation progressed due to more practice teaching.

Results from the preservice teacher weekly reflections. The preservice teachers were asked to complete weekly reflections throughout the innovation to help answer all three of my research questions: 1) How and to what extent does lesson study influence instructional planning by preservice secondary mathematics teachers? 2) How and to what extent does lesson study influence the instructional effectiveness of preservice secondary mathematics teachers? 3) How and to what extent does lesson study influence the teacher efficacy of preservice secondary mathematics teachers? In most cases I provided prompts for the preservice teachers; however there were some weeks that no prompts were provided. Some examples of prompts used for the weekly reflections were:

- How is your group planning going?
- How are you feeling about teaching in your field experience classroom?
- What are the three most important ideas you have learned from this class so far? Explain.
- Are you more confident now when you know you will be teaching? Why or why not?
- How did you feel about finally teaching in front of real students in your field experience?
- What are you biggest strengths as a future math teacher? What might be your biggest weakness still? Explain.

The four themes, components from which the themes resulted, and assertions are noted in Figure 10.

Themes	**Theme Related Components**	**Assertions**
Building Confidence	Confidence was gradually building from rounds of practice teaching. Confidence improved from teaching in the field experience classroom.	Preservice teachers gained confidence from multiple teaching opportunities.
Collaborative Planning	Collaborative planning was difficult for some teams initially. The lesson study teams eventually thrived from the collaborative planning.	Collaborative planning was a major benefit to the lesson quality.
Practice Teaching	Practice teaching improved preservice teachers' instructional ability. Practice teaching improved the preservice teachers' confidence. Practice teaching before field experience essential to the success of the preservice teachers.	Practice teaching in the classroom and field experience was essential to the growth of the preservice teachers.
Observation of Instruction	Observing themselves on video helped them to reflect on their own teaching. Observing the instructor model-teach lessons helped them to gain more ideas. Observing their peers teach allowed them to see other ways to teach.	Observing themselves and others improved the reflective practices and effectiveness of the preservice teachers.

Figure 10. Reflection themes

The first theme that resulted from the weekly reflections was the idea of *building confidence*. There were two components that led to this theme. The first was that the preservice teachers' confidence was gradually building from rounds of practice teaching. The second component was that the preservice teachers' confidence improved from teaching in the field experience classroom. In Week 3 a preservice teacher noted, "Well, I have to say that I was very nervous teaching for the first time in front of my peers. But, after realizing we all had wobbly knees about it, I guess it wasn't really that bad." In the same week, a preservice teacher mentioned the fear of the upcoming field experience teaching, "I'm nervous about the differences in a real high school classroom." In Week 4 a preservice teacher discussing their confidence stated, "I would say my confidence is in a good spot right now. I don't feel overly confident, but I'm not in a situation where I'm rethinking my career if that makes sense." In Week 5 before teaching the first field experience lesson a student wrote,

> To be completely honest, I am really nervous about teaching in the practicum classroom. I have never taught a lesson in an actual high school classroom before, so it should be interesting. I feel more comfortable with the practice that I've gotten in class.

However, after the first field experience lesson you see the shift in the confidence of the preservice teachers. After the first field experience teaching, one preservice teacher pointed out,

> The teaching experience was by far the most beneficial thing I have done so far. Even though we teach lessons in our own classroom each week, being in an actual high school classroom with real students had a much different feel.

By Week 8, one preservice teacher made this statement, "I am much more confident in my own abilities, which makes it much easier to focus on the students and their learning

rather than worrying about messing up my teaching." By Week 12 after the final field experience teaching, one preservice teacher wrote, "After stressing out for a week about the teaching, I felt it went really well. The nervousness went away almost immediately this time, so I guess that means my confidence is getting better." Another preservice teacher stated the same week, "I felt more comfortable with my ability to teach the students, and to hold their attention. Just from a confidence stand point I felt better about this lesson." Finally, one preservice teacher summed up the final reflection by stating, "I would say that I definitely felt a lot more confident and teacher-like instead of college student-like." The components that led to the theme *building confidence* led to the assertion that the preservice teachers gained confidence from multiple teaching opportunities.

The second theme that came from the preservice teacher reflections was the idea of *collaborative planning*. There were two components that led to this theme. The first component was that collaborative planning was difficult for some teams initially. The second component was that eventually the lesson study teams thrived from the collaborative planning. One team worked more effectively than the other team right from the start, but the other team did eventually become highly effective in their collaboration. For example, in Week 2 of the innovation one preservice teacher on the team that struggled early said, "This week has been very trying for me. I feel as though we didn't have enough time to collaborate on our lesson plans. Also, I found myself not feeling comfortable in expressing my opinion to my group." However, by Week 4 that same preservice teacher stated,

> The group planning is going better. Having more time in class to collaborate with our groups has been really good. I think we all have a feel for each other's personality and style so it's a bit easier to adjust ourselves to help the planning process flow.

Another member from that same team said after Week 3 of the innovation that, "Working in teams is helpful, but sometimes it can be difficult to make a lesson that everyone can feel good about."

A member of the other lesson study team stated after Week 4 that, "I think our group planning is going great. We work really well together and everyone has a chance to share the ideas and give their opinion." Another preservice teacher from that same lesson study team that same week added, "When one of us has a different idea, the others are willing to listen and incorporate that idea into the lesson." In Week 7, one preservice teacher from the lesson study team that thrived from the beginning of the innovation stated,

> We work incredibly well together. We share similar ideas, but when we have differing ideas, they help stimulate discussion that leads to an even better idea. I think we collaborate really well when creating our lessons. Because every person brings a slightly different perspective, we are able to mesh those ideas together to create a better lesson as a group than any of us could create on our own.

The lesson study team that struggled to plan collaboratively early in the innovation sounded much different by Week 9 of the innovation when one of them wrote, "I definitely think we are working as a group much better. We are getting more ideas flowing and starting to sort out what we think will work and will not work. It feels more collaborative than previous lessons." By Week 10, one preservice teacher stated when talking about the planning process for the last field experience lesson that, "It wasn't so much about how we were going to teach, rather how we were going to make it exciting

for the learners." The components of the theme *collaborative planning* led to the assertion that collaborative planning was a major benefit to the lesson quality.

The third theme from the preservice teacher reflections was *practice teaching*. There were three components that led to this theme. The first component was that practice teaching improved the preservice teachers' instructional ability. The second component was that the practice teaching improved the preservice teachers' confidence. The third component was that practice teaching before the field experience was essential to the success of the preservice teachers. In the Week 2 reflections after teaching their first lesson in class, one preservice teacher stated, "I feel after teaching just this one lesson that I definitely need much more practice." That same week another preservice teacher pointed out that, "…everything I have done up to this point has just been practice or in theory teaching. Actually going through the lesson planning process and teaching the lesson is a completely different feeling." By Week 6 after the first field experience lesson, one preservice teacher stated, "I feel like overall, the lesson went very well although there are certainly things that I can work on." By Week 7, one preservice teacher said, "I have taught four times already, between the snippets in class and the full day at the high school." In Week 8 when asked about one of the most important things they had learned in this class so far, one preservice teacher said, "By far the most important thing I have learned is that I need to become more assertive when delivering my instruction." By Week 10, one preservice teacher noted, "I think I am starting to adapt my own rhythm/style of teaching." It seems evident that the more practice teaching each preservice had the better their skills and confidence increased. The components of

the theme *practice teaching* led to the assertion that practice teaching in the classroom and field experience was essential to the growth of the preservice teachers.

The fourth theme that resulted from this data was *observation*. There were three components that led to this theme. The first component was that observing themselves on video helped them to reflect on their own teaching. The second component was that observing the instructor model-teach lessons helped them to gain more ideas. The third component was observing their peers teach in the classroom and field experience helped them to see other ways to teach. One preservice teacher said after observing their lesson on video in Week 4 said, "After watching that first video of me teaching, I realized that all those little things that you think of as wrong while you are presenting are not very noticeable." Another preservice teacher that week stated, "It was really helpful to have our instructor demonstrate for us. His example of pacing and questioning was really nice." Right before the first lesson in the field experience classroom in Week 5, one preservice teacher said, "After visiting the field experience classroom yesterday, I feel a bit more comfortable about teaching in her class." In Week 6, a preservice teacher pointed out the benefits of teaching a lesson in the field experience classroom after both teammates had already taught, "…I had the advantage of seeing what worked what didn't." Another team member that same week stated, "Getting to see and hear the same lesson numerous times really helps me to reflect on how I will teach the lesson." In Week 7 after the first field experience lesson, one preservice teacher said,

> … we were able to use what we saw one person do, and put our own style on it….I was able to watch my teammates and see what worked for them, and then use that idea in my own teaching. It was very interesting to see all of us teach the same lesson in different ways, and I think seeing that difference just helps your own teaching become that much stronger.

In the final week of reflections, one preservice teacher summarized how different they felt after teaching for the second time in the field experience classroom by stating, “I was able to draw some good things from my teammates, which helped me to improve.” Another preservice teacher that same week mentioned, “…I think I felt good because I knew I wasn’t going to be the first one to teach. I was going to have an opportunity to see what was going to work and what I might need to change…” The components of the theme of *observation* led to the assertion that observing themselves and others improved the reflective practices and effectiveness of the preservice teachers.

Results from the semi-structured interviews. All six preservice teachers in the study were interviewed following the innovation (see Appendix E) to answer the following research questions: 1) How and to what extent does lesson study influence instructional planning by preservice secondary mathematics teachers? 2) How and to what extent does lesson study influence the instructional effectiveness of preservice secondary mathematics teachers? 3) How and to what extent does lesson study influence the teacher efficacy of preservice secondary mathematics teachers? The three themes, components from which the themes resulted, and assertions are outlined in Figure 11.

Themes	Theme Related Components	Assertions
Collaborative Planning	Gained different ideas about how to teach. Anticipating student misconceptions critical to their success (new to them).	Collaborative planning was essential for improving the quality of the lessons.
Growth in Confidence (Efficacy)	Confidence increased with more practice teaching (especially in field experience). Reflecting/Debriefing/Revising/Re-teaching helped to build confidence in their lessons.	The preservice teachers' confidence continued to grow as the innovation progressed.
Practice Teaching (Real Experience)	Practice teaching in classroom with their peers a safe way to start before field experience. Planning and teaching a math lesson, in addition to writing the lesson plan, enhanced the preservice teachers' experience.	Practice teaching in the classroom and field experience was essential to growth of the preservice teachers.

Figure 11. Interview themes

The first theme from the interviews was *collaborative planning*. There were two components that led to this theme. The first component was that the preservice teachers gained different ideas about how to teach from their collaborative teams. The second component was that the concept of anticipating student misconceptions was critical to their success and something they had not thought of before this innovation. One preservice teacher stated, "I think being able to work in a group and get different ideas of how to create lesson plans and different ways to implement them and different ideas was really beneficial." Another preservice teacher when asked about the main benefits of lesson study said, "I think the key benefit was getting input from the group members on

the actual planning of the lessons." Another preservice referred to the collaborative planning by saying,

> You know you don't typically get to do that and having other people's feedback is really nice even if it's something to where their ideas slightly differ, it is still nice to see how other people think about it because you get more benefits out of it.

One preservice teacher summed up the benefits of collaborative planning by saying, "…it helped a lot with getting a little more diverse ideas and other people's perspectives outside of my own and I think that really opened me up a little bit to different ideas and different strategies to teach." Another preservice teacher pointed out the importance of looking for possible student misconceptions during the planning stage by saying,

> We tried to anticipate some of the hiccups that the kids might encounter in the lesson like things that they might get confused on…We try and clear those things up as you're teaching it. I thought that was really interesting because it is something I had not thought of before. Instead of letting them get confused, just straighten it out right out of the chute and then everything will be fine….

The components from the theme *collaborative planning* led to the assertion that collaborative planning was essential for improving the quality of the lessons.

The second theme was *growth in confidence*. There were two components that led to this theme. The first component was that the preservice teachers' confidence increased with more practice teaching, especially the field experience teaching. The second component was that the reflecting, debriefing, revising, and re-teaching helped to build confidence in their lessons. One preservice teacher stated, "I feel like I'm more prepared to go into my student teaching having gone through the lesson study process…" Another preservice teacher said it this way, "Having the opportunity to teach and get in front of a classroom before leaving the university and going into my student teaching next semester it just increased my comfort level a thousand fold." When asked if the

classroom is a piece of cake now, this same preservice teacher stated, "I am still scared, but not quite as much." One preservice teacher summarized the field experience teaching by stating, "…just being able to do it and tell myself that I did it and it wasn't so hard boosted my confidence level…" One preservice teacher summarized how their confidence was impacted by the reflecting, debriefing, revising and re-teaching their lessons this way,

> So you take all of the thoughts into consideration and make all of your changes and you have that much better of a lesson and then you get to re-teach it and again it is that much better a teaching lesson because you remember what they told you and you make the changes necessary …and because it did go better it boosts your confidence. Then you feel more comfortable teaching and it is like a giant cycle and it works well to improve all of your teaching abilities.

The components from the theme *growth in confidence* led to the assertion that the preservice teachers' confidence continued to grow as the innovation progressed.

The third theme was *practice teaching (real experience).* There were two components that led to this theme. The first component was that the practice teaching in the methods classroom with their peers was a safe way to start before moving into the field experience teaching. The second component was that planning and teaching a math lesson, in addition to writing the lesson plan, enhanced the preservice teachers' experience. The idea of starting out teaching in front of their peers seemed to be something that benefitted the preservice teacher as one preservice teacher said, "…you get to work out all of the kinks in front of your peers and they tell you all of the things they think went good and things that could possibly change for the better." In fact, practicing the exact lesson before the field experience classroom seemed to impact the innovation. One preservice teacher noted,

> …we could teach the lessons in class and then get our revisions and make those changes and see what worked and what didn't work…and make those changes for the high school students…it was like a lesson we already taught three times as opposed to doing something for the first time.

When asked about the main benefits of the lesson study process, one preservice teacher said, "…the most beneficial for me was actually teaching in our class here and the one in the field experience classroom." When asked if they did this sort of thing in their other methods classes, they said, "I had never actually made I guess you could call it a real life math lesson before." One preservice teacher added this key point about the real life practice, "…with most of our classes now we just write lesson plans, but being able to actually teach it helps to see what are some flaws that you might have that you didn't think of before." The components from the theme *practice teaching (real experience)* led to the assertion that practice teaching in the classroom and field experience was essential to the growth of the preservice teachers.

Chapter 5

FINDINGS

This chapter begins by merging the quantitative and qualitative data to answer each of the three research questions posed at the beginning of this study. The chapter then concludes with the presentation of the final warranted assertions that serve as the overall findings for this study. To answer the three research questions and develop the assertions, I triangulated the quantitative results with the qualitative assertions from Chapter Four. Triangulation refers to the process of using multiple data sources to obtain a valid representation of what is being studied (Gay et al., 2009). By using different methods to measure the same phenomenon, I attempted to add validity and reduce the natural bias in my study (Greene, 2007). I interpreted the data through the theoretical lens of Vygotsky's Space, which was discussed in Chapter Two. The four stages of *appropriation*, *transformation*, *publication*, and *conventionalization* from Vygotsky's Space provided insight into my interpretation of the results.

Research Question 1

How and to what extent does lesson study influence instructional planning by preservice secondary mathematics teachers? A major aspect of this innovation was the collaborative planning of math lessons by the preservice teachers. This study found that when preservice teachers participated in collaborative planning they became more open to different teaching styles and increased their confidence in their lessons which was congruent with previous research on lesson study (Carrier, 2011; Chassels & Melville, 2009; Ganesh & Matteson, 2010; Post & Varoz, 2008). This study also found that the preservice teachers improved at predicting student misconceptions, which eventually led

to a more student-centered approach to their lessons. This also aligns with current research on lesson study (Hiebert et al., 2007; Mathews et. al., 2009; Sims & Walsh, 2008). Overall, the merger of quantitative and qualitative data clearly demonstrated that the lesson study process positively impacted the instructional planning of the preservice teachers in this study.

For each of the four lesson studies, teams were required to submit, among other things, a detailed lesson plan that included the actual math examples and handouts they would use in their lesson. Writing detailed lessons such as this served as a major factor in the growth of the preservice teachers planning ability. It was the first time in their university experience that they planned an actual math lesson that they would be teaching with the specific problems and activities. The collaborative lesson planning teams had to decide on not only which mathematical examples to use in their lessons, but also how to teach them to the students. Learning to take a mathematical idea and deconstruct it for the students strengthens teachers' pedagogical-content knowledge (Ball, 2000; Hiebert et al., 2007).

The preservice teachers showed consistent growth for the construct *planning* from the Lesson Study Planning and Instructional Rubric indicating improvement in lesson planning from the beginning to end of the innovation. In support of this finding, the construct *collaborative planning* from the Lesson Study Questionnaire had a mean score of 4.47 out of a possible 5.0. This demonstrated that the preservice teachers "Strongly Agreed" collaborative planning had a positive impact on their planning. The construct *debriefing*, a component of the lesson study process although not directly focused on planning, also affected their revisions of future plans. The mean for *debriefing* was 4.80

on a 5.0 scale. The construct of *revising lessons* had a mean of 4.8 on the 5.0 scale. The preservice teachers felt strongly that planning collaboratively both before and after teaching improved their lessons. Overall, the quantitative data clearly demonstrated that this innovation positively impacted the planning of the preservice teachers in this study.

The qualitative data supported the proposed link between lesson study and preservice teachers' instructional planning with *collaborative planning* emerging as a theme in all data sets. Data from the Lesson Study Questionnaire found that the preservice teachers' confidence increased from planning collaboratively. The preservice teachers also gained new viewpoints for their lessons from working on a collaborative team during the instructional planning of their lessons. The weekly reflections demonstrated evidence that both lesson study teams thrived by working collaboratively despite one team struggling early in the innovation.

The interview data reinforced the analysis of the weekly reflections as the preservice teachers pointed out that collaborative planning provided them with different ideas on how to teach their lessons. They were also able to anticipate student misconceptions more effectively due to the collaboration. This could have been due to the use of the Japanese four-column lesson plan as an additional planning support. That lesson plan format includes a column for "expected student responses" and how the teacher would respond to those possible student issues. When preservice teachers are contemplating student responses ahead of time, they are typically more confident in their teaching (Sims & Walsh, 2008), which coincided with the interview data from this study. Overall, the preservice teachers' lesson quality was improved from working collaboratively.

The data on instructional planning demonstrates movement through the four stages of Vygotsky's Space. The first stage relates to the *appropriation* of particular ways of thinking through interaction with others. This was evident through the collaborative planning and how the preservice teachers gained different ideas from their teammates. The second stage of Vygotsky's Space is individual *transformation*. This was demonstrated in the gradual shift from a teacher-centered to a more student-centered approach discussed previously. Their lesson plans started to focus on anticipating possible student misconceptions, which was a shift (transformation) in their thinking. The third stage of Vygotsky's Space is the *publication* of new learning through talk or action. This was evident through their final lesson plan after the revisions that they had to teach in the field experience classroom. The preservice teachers had a final refined version of this lesson, yet how they chose to instruct was up to them. The final stage of Vygotsky's Space focuses on the *conventionalization* of that practice. This was demonstrated later in the innovation as each preservice teacher was able to take the collaboratively-planned lesson and teach it in their own way. This demonstrated that they were beginning to come to the point of conventionalizing their own practice as future mathematics teachers based on this innovation.

By triangulating the quantitative (rubric and questionnaire) and qualitative (questionnaire, weekly reflections, and interviews) data, it is evident that the instructional planning of the preservice teachers was positively impacted by lesson study. The data indicates that by collaboratively planning lessons the preservice teachers not only improved their lesson quality, they also felt more confident in their ability to plan mathematical lessons. The innovation also allowed them to revise their lessons

collaboratively which improved their lesson quality. A critical component of planning that emerged from the data set was the vastly improved idea of predicting student misconceptions during the planning of their lessons. This began to shift their focus from planning based on what "they were going to do" to planning for "how might the students learn this best." This demonstrated a major improvement in their instructional planning ability from a teacher-centered to a more student-centered approach. Lesson study's main goal is not just to improve lesson plans, although that is important. The goal for preservice teachers participating in lesson study according to some current research is the professional growth from collaborating about math teaching that occurs in this type of innovation (Chassels & Melville, 2009; Groth, 2011; Post & Varoz, 2008; Tolle, 2010). This study clearly demonstrated a major growth in instructional planning for the preservice teachers.

Research Question 2

How and to what extent does lesson study influence the instructional effectiveness of preservice secondary mathematics teachers? The preservice teachers in this study lacked experience teaching, even in the shelter of a university classroom. This innovation included multiple teaching experiences in the methods and field experience classrooms. In addition, student teaching follows this course, so the urgency for improved instructional ability was heightened. One of the goals of this innovation was to help bridge the gap for the preservice teachers from a methods classroom to a field experience classroom and eventually into their student teaching. The data clearly demonstrates that this innovation had a positive impact on the instructional effectiveness of the preservice teachers.

The innovation began with teaching lessons in the methods classroom followed by revisions and re-teaching. There is considerable research that demonstrates the importance of giving preservice teachers multiple practice-teaching opportunities with adequate support (Bowman & McCormick, 2000; Chassels & Melville, 2009; Morris et al., 2009; Tobin et al., 2001). By the third round of lesson study, the preservice teachers were practice-teaching the lessons that they eventually taught in the field experience classroom. Some research encourages a direct link between the methods classroom and field experience classroom (Carrier, 2011; Chassels & Melville, 2009; Sims & Walsh, 2008) because many preservice teachers do not always see the connection between the methods classroom and field experience (Darling-Hammond, 2006b, Lampert & Ball, 1999). Although the planning was collaborative, the teaching of the lessons was done on an individual basis. Each preservice teacher was allowed to teach their collaboratively-planned lesson in the way they thought would be most effective. There were many times when individual preservice teachers made minor adjustments to the lesson plan or implemented the same lesson in a much different way during their instruction.

The evidence to support my conclusion came from merging four data sources that each had aspects that focused on instructional effectiveness. The four data sources used to answer this question were the Lesson Study Planning and Instructional Rubric questions 4 – 10 (quantitative), my own field notes and video analysis (qualitative), the preservice teachers' weekly reflections (qualitative), and the semi-structured interviews (qualitative).

The Lesson Study Planning and Instructional Rubric included the constructs of *content knowledge* and *instructional strategies* that were focused on instructional

effectiveness. The means for content knowledge from Round 1 to Round 4 improved from 2.55 to 3.50 on a 4.0 scale. Similarly, the construct on instructional strategies increased from 2.25 to 3.25 on a 4.0 scale from Round 1 to round 4. These scores were impressive because the last two rounds were scores from their actual lessons in the field experience classroom.

Two of the three themes from my own field notes and video recordings related to instructional strategies. One theme was that the preservice teachers moved from a *teacher-centered to student-centered* approach in their instruction. The preservice teachers were shifting the focus of their instruction away from themselves and towards the learners. The second theme from my field notes was that *individual teaching style* for each preservice teacher began to emerge. The preservice teachers' explored different ways to teach as the innovation progressed. Evidence demonstrated that the collaboratively-planned lesson was taught differently by each preservice teacher as the rounds of the lesson study progressed.

Two of the four themes from the weekly reflection data set focused on instructional ability. One of the themes was *practice teaching*. The preservice teachers improved in their instructional ability from practicing more and receiving feedback. Practice teaching the same lesson before teaching it in the field experience classroom was a key component from the data. *Observation of instruction* was also a theme from the weekly reflections. Since there were debriefing sessions after each lesson in class, the preservice teachers became more reflective about their own instruction as well as the lessons from their peers and instructor.

The semi-structured interviews also showed strong evidence of improved instructional ability as one of the three themes of this data source was *practice teaching (real experience)*. Planning and teaching the actual math lessons instead of just a using a written lesson plan enhanced the preservice teachers' real experience. Teaching these real-life math lessons in the methods classroom and field experience enhanced the instructional ability of the preservice teachers in this study.

In summary, the triangulation of quantitative and qualitative results from the rubric, field notes, weekly reflections, and interviews demonstrate that the innovation did positively impact the instructional ability of the preservice teachers. The preservice teachers went from teaching the collaboratively-planned lesson virtually the same early in the innovation to gradually showing their own style of instruction as the innovation progressed. In fact, one preservice teacher stated in the Lesson Study Questionnaire, "Being able to see my teammates teach the same lesson but in a different way solidified my style of teaching, and the fact that it is okay to have a different style." This demonstrated that the preservice teachers were starting to move through the four stages of Vygotsky's Space in their instructional ability similar to how they did in their planning. This innovation clearly allowed these preservice teachers the opportunity to explore different ways to teach. By the final teaching in the field experience, the preservice teachers were focused on making the lesson more exciting for the students. This was a major shift in their instructional ability to teach secondary mathematics.

Research Question 3

How and to what extent does lesson study influence the teacher efficacy of preservice secondary mathematics teachers? Some previously cited research suggests

that efficacy can be increased from collaboration and support for preservice teachers (Chester & Beaudin, 1996; Rosenholtz, 1989; Tschannen-Moran & Woolfolk-Hoy, 2007). In fact, lesson study itself has been shown to positively impact self-efficacy (Sibbald, 2009). The evidence strongly supports that the preservice teachers' efficacy to teach mathematics was positively influenced by this innovation.

I merged three different sources to answer this question. First, I used a pre-post efficacy survey (quantitative). This allowed me to measure the preservice teachers' efficacy beliefs before and after the innovation. I also used the preservice teachers' weekly reflections (qualitative) to find out how they felt from week to week about various parts of the innovation including their confidence. This data source was invaluable because it allowed me to measure their how their efficacy fluctuated throughout the innovation. Finally, I used the semi-structured interviews (qualitative) that were done following the innovation. These gave me very rich data about the preservice teachers' efficacy because confidence was mentioned throughout their interviews even when some of the questions were not pertaining to it specifically.

The results of the pre-post efficacy survey demonstrated that there was a significant growth based on the t-test results for both Personal Mathematics Teaching Belief and Mathematics Teaching Outcome Expectancy. Personal teaching belief is "a belief in one's ability to teach effectively," and teaching outcome expectancy is "the belief that effective teaching will have a positive effect on student learning" (Enochs et al., 2000).

The qualitative data also demonstrated positive results in the area of efficacy to teach mathematics. One theme from the weekly reflections was *building confidence*.

The preservice teachers gradually built their confidence from rounds of practice teaching. Their confidence also was impacted by teaching in the field experience classroom. What I found interesting was the fluctuation in the confidence of the preservice teachers during the innovation. The preservice teachers were somewhat low in confidence early in the innovation before teaching in front of our methods class. After the first teaching lesson in the methods class, their confidence gradually rose until the first field experience lesson. Right before the first field experience teaching their confidence dipped due to fear from never teaching in a real classroom. Two things helped to ease their fears based on the data. First, the preservice teachers all observed the field experience teacher and classroom a few times before actually teaching. This helped them to feel more comfortable in the environment of the field experience classroom as well as see the style of teaching of the field experience teacher. Second, they were also able to teach and revise the exact lesson in our methods classroom before going to teach it in the field experience classroom. After the first field experience lesson, their confidence went back up and continued to grow throughout the rest of the innovation. By the end of the innovation, the preservice teachers were much more confident going into their student teaching for next semester.

The semi-structured interviews also demonstrated positive results in the area of improved efficacy to teach mathematics. One theme from the interviews was *growth in confidence (efficacy)*. The fluctuation in confidence was not as evident in the interviews as in the weekly reflections. This is possibly because the interviews were only given following the innovation. The preservice teachers' confidence increased with more practice teaching, especially in the field experience classroom. Also, the reflecting,

debriefing, revising, and re-teaching helped to build confidence in their lessons. One of the preservice stated the following about the feedback, revising, and re-teaching with lesson study compared to other university courses,

> …you get your grade in other classes and it is not like you edit your lesson and they will change your grade or something. So I think when I did my other lessons as soon as I got my grade I was done with that lesson. But when we did the lesson study it was like 'this didn't work well so let's fix it' so that you can actually use this lesson to teach again…

As mentioned in the previous two research questions, the movement through the stages of Vygotsky's Space was evident throughout this innovation. The preservice teachers gradually moved from *appropriating* a new practice with this innovation to *transforming* their mathematical planning and teaching. They then *published* their learning through a final revised lesson in the field experience classroom. The hope is that this will become a *conventionalized* skill as mentioned in Vygotsky's Space that they can use in student teaching and beyond. It is obvious that the movement through these four stages from Vygotsky's Space positively impacted the efficacy of the preservice teachers in this study.

The quantitative and qualitative results were triangulated based on the pre-post efficacy survey, weekly reflections, and interviews. The data clearly demonstrates that the preservice teachers' efficacy to teach mathematics was drastically improved as a result of this innovation. Although the efficacy fluctuated at times during the innovation, it grew a great deal from the beginning to end of the innovation. For example, many of the preservice teachers in this study were very nervous just to teach in front of their peers in our methods classroom when the innovation began. However, by the end of the innovation, they were confident teaching to our methods class and in the field experience

classroom. In addition, some research points out that the shift from a teacher-centered to student-centered outlook could be linked to higher teacher efficacy (Czerniak, 1990). The preservice teachers in this study felt much more confident about their ability to plan and teach mathematics as they enter their student teaching experience. This innovation clearly helped to create a bridge between their methods course, field experience classroom, and their student teaching.

Warranted Assertions

This study demonstrated evidence of six major findings. The following are the warranted assertions that resulted from the data in this study:

- The preservice teachers improved their lesson quality from planning and revising their lessons collaboratively.
- The preservice teachers increased their confidence to teach mathematics from collaborative planning, teaching, debriefing, revising, and re-teaching.
- The preservice teachers improved their instructional ability due to multiple practice teaching and re-teaching opportunities in the methods and field experience classrooms.
- The preservice teachers began to shift their planning and instruction from a teacher-centered approach to a more student-centered approach due to planning collaboratively and having multiple teaching opportunities in the methods and field experience classrooms.
- The preservice teachers gradually began to demonstrate their own individual style in their instruction due to multiple teaching opportunities in the methods and field experience classrooms.

- The preservice teachers improved their observation and reflection skills from participating in debriefing sessions following their own instruction as well as their peers and instructor.

Chapter 6

CONCLUSIONS

When I designed this innovation, I had many things I hoped to accomplish with my preservice secondary mathematics teachers. First, I wanted them to learn to collaborate on a team with meaningful discussions about math teaching and learning. I wanted the collaboration to improve their ability to plan math lessons by seeing other viewpoints. Second, I wanted my preservice teachers to get more practice teaching than is typical in methods classrooms at my institution. I know the typical methods classroom has each preservice teacher teach one or two mini-lessons for the entire semester. This innovation called for much more practice teaching that eventually would lead to teaching in the field experience classroom. Third, I wanted to connect the field experience to our methods classroom. I wanted field experience to allow preservice teachers to practice the lessons in our class before teaching them in their field experience classroom. I did not want my preservice teachers to just be "thrown into" a classroom to teach, but rather to have a foundation built from observing the teacher and practicing the assigned lesson beforehand.

Fourth, I wanted my preservice teachers to be adequately confident going into their student teaching the semester following the innovation. I knew the only way to do that was to have them practice in an actual field experience classroom environment. Fifth, I hoped that the preservice teachers in this study would improve their ability to plan and teach math lessons. As future mathematics teachers, much of their time will be spent planning and teaching math lessons, so the more experience they could get doing this before their student teaching the better prepared they would be to succeed. I wanted the

preservice teachers to start to notice the small details required to plan effective math lessons. Sixth, I wanted them to be able to observe, reflect, analyze, and discuss mathematics teaching. I knew this innovation would call for them to reflect on their own teaching as well as observe and discuss other lessons. I was hoping that through this innovation that the preservice teachers would start to look at math instruction in a more critical manner and learn to discuss it and make changes to their own pedagogy based on what they learned.

The preservice teachers did in fact learn to collaborate with their lesson study teams during the innovation. They improved their lesson plans and confidence from working on a team. They also were able to see other viewpoints and discuss mathematics planning and teaching in their lesson study teams.

It was evident that the increased amount of practice teaching improved the instructional skills of the preservice teachers. Some research suggests that just planning and teaching lessons for the first time can be overwhelming for preservice teachers (Carrier, 2011). With that in mind, I believe that the lessons in our classroom provided a good transition before moving to the field experience classroom. In fact, I observed gradual improvement from each preservice teacher in his or her instructional abilities in our classroom before moving to the field experience classroom.

As I hoped, this innovation allowed for a partnership with a field experience school and classroom. This partnership provided a way to gradually implement the preservice teachers into their field experience teaching. Some research cited previously contends that preservice teachers are strongly influenced by coursework that connects to

their field experience (Darling-Hammond, 2006a; Feiman-Nemser, 1983; Lampert & Ball, 1999; Tabachnik et al., 1979-1980).

By the end of the innovation, the preservice teachers seemed much more prepared and confident for their student teaching. As one study claims, this might have been due to being able to learn from actual teaching in the classroom rather than just learning through theory (Sims & Walsh, 2008). This innovation did in fact form a bridge for the preservice teachers from their methods classroom into their student teaching as I had hoped it would.

The preservice teachers in this study clearly improved their math planning and teaching skills. They were able to plan and teach multiple lessons. They improved on the details of their planning as well as anticipating possible student misconceptions. I observed them try new pedagogical strategies as they gained more experience teaching. This eventually led them to start to form their own individual style in their instruction.

The amount of reflection, observation, analyzing, and discussing of mathematical planning and teaching really helped the preservice teachers to grow in their content and pedagogical knowledge. Due to the format of this innovation, when a preservice teacher was not teaching, they were often observing others teach and participating in the debriefing sessions. This was a two-fold benefit in my opinion. The preservice teacher who taught the lesson received valuable feedback on their instruction. Further, the other preservice teachers took on a role of analyzing the lesson and offering the feedback. Some research even suggests that teacher efficacy will increase from observing teaching strategies modeled along with participating in self-reflection about their own teaching

like what occurred in this innovation (Henson, 2001; Johnson, 2010; Schunk & Zimmerman, 1997).

Unintended Effects

There were three effects that emerged from this innovation that I did not anticipate. The first was the preservice teachers' gradual shift from a more teacher-centered to student-centered approach in their planning and teaching. I did not anticipate this shift during my innovation despite some of the research pointing out this was a possible benefit. I believe, as previously mentioned, the Japanese four-column lesson plan helped to initiate this shift in the thinking of the preservice teachers' planning since they had to start predicting possible student misconceptions and implement plans for dealing with them. I noticed when revising their lesson plans that these columns that required anticipating student misconceptions were the most difficult for the preservice teachers early in the innovation. However, as the innovation progressed, it became almost a fun challenge for the preservice teachers to try and anticipate possible misconceptions from the students and figure out ways to alleviate them. The shift in their thinking away from their own teacher actions to that of the learners demonstrated a major growth in their development as future mathematics teachers.

Another effect that I did not expect was that the preservice teachers began to demonstrate their own individual style of instruction as the innovation progressed. This is something that I have not observed in my previous years of teaching this course. Possibly there were not enough practice teaching experiences for the preservice teachers to allow them to explore different ways to teach and begin to form their own style in my past methods courses. Observing others teach often during this innovation could also be

part of the reason since they were able to see many different styles of math teaching from their peers, field experience teacher, and me. Either way, it was a very positive benefit that was not expected that resulted from this study.

Third, I did not anticipate the impact that planning the actual math lesson and activities instead of a just using a written lesson plan would be to the success of this innovation. The feedback from the preservice teachers cited previously has made me reconsider how I assign lesson plans for my preservice teachers in all of my future education courses. Writing a lesson plan is obviously very important for preservice teachers, but I have realized that they need to be able to transfer that written lesson plan into the actual plan and materials they will use in their lesson with their students.

Implications for Practice

The implications for practice are significant. Lesson study is an effective method of pedagogy to use with preservice teachers in a methods course for several reasons discussed in this study. In lesson study, preservice teachers are given the opportunity to grow professionally through collaborative planning, practice teaching, debriefing, revising, and re-teaching as previous research in this study has stated (Cohan & Honigsfeld, 2006; Post & Varoz, 2008; Takahashi & Yoshida, 2004; Tolle, 2010). This study found that collaborative planning enhanced not only the lessons of the preservice teachers, but also their confidence teaching. It also provided multiple teaching opportunities in our classroom and eventually the field experience classroom. The preservice teachers were able to receive structured feedback not only on their lesson plans, but also on their instruction. This feedback then was used to allow them to revise and re-teach. It has been shown that lesson study can be used as a bridge from a

university methods classroom to the field experience classroom when they are connected. In fact, lesson study has shown to be an effective tool to improve the efficacy of the preservice teachers. However, possibly the most important implication for practice is that lesson study allowed the preservice teachers to engage in mathematical discussions about teaching and learning which enhanced their professional growth.

Possible Issues for Implementing Lesson Study

Although the benefits far outweighed any struggles in my innovation, there are still some concerns that need to be addressed for instructors intending to use lesson study with preservice teachers. Some of those concerns will vary depending on the university setting and field experience partnerships. Some possible issues that could emerge might concern the class size, team dynamics, field experience partnership, and the field experience teacher.

Class size. The size of your class can be a major concern for educator's implementation of lesson study. My class had eight preservice teachers (six were part of the study). I had three lesson study teams (the two students who chose to not be part of the study formed their own team). If my class had double or triple the amount of preservice teachers, it would have been very difficult for me to implement this innovation in the same manner. Finding the class time to allow each preservice teacher to teach lessons and get feedback would have been a challenge. By only having such a small number of participants in my study, I was able to have each preservice teacher get multiple teaching opportunities. I think it is possible to still use lesson study with a large class of preservice teachers, but the instructor would have to be much more creative to allow for multiple teaching and observing opportunities.

Team dynamics. A possible concern for instructors implementing lesson study with preservice teachers might be the team dynamics. I used groups of three preservice teachers for each lesson study team. I had one team that was not working effectively at the start of the innovation. I found myself sitting with that team and defining roles for the first round of lesson study. They eventually collaborated very successfully, but team dynamics could possibly be an issue when using lesson study. I did find that giving class time to collaboratively plan was my most effective way to enhance team production. In fact, the entire concept of lesson study is so different from the typical methods class that thorough explaining and guidance early in the process was essential.

Field experience partnership. A possible concern for university instructors in implementing lesson study is making sure you have solid partnerships with local schools in order to implement the field experience teaching. I was able to partner with one school and one math teacher which made it much easier for me to align my class with the field experience classroom. With a larger class of preservice teachers, one would need more than one field experience teacher and possibly more than one school partnership. The scheduling could be more complicated in this situation. However, the benefits of the field experience aspect of this innovation are worth the difficulty in scheduling. Building close partnerships will be vital to having effective lesson study experiences.

Field experience teachers. It is critical to have good communication with the field experience teacher(s) and the style of teaching that is incorporated in their classroom. For example, I had my preservice teachers in this study observe the field experience teacher at least twice before teaching there in order to get a feel for the school, teacher, style, and students. Communication with the field experience teacher about the

pre-requisite skills, lesson details, and methods of teaching were essential to the preservice teachers' transition into the field experience classroom. In this study, I kept in constant communication with the field experience teacher which I believe enhanced the transition from our classroom to theirs.

Future Implications

As mentioned in previous chapters, lesson study has started to emerge as an effective method for preservice education. The many benefits for the preservice teachers are evident. At my university, lesson study was never used in the past and had not been considered as a preservice teacher methodology. In gaining approval for my study, the university gave me permission to attempt this innovation in my attempt to improve my own practice for this secondary mathematics methods course. I am grateful for this opportunity because it has allowed me to grow professionally in the area of lesson study with preservice teachers.

Possible changes for future lesson study innovations. Although this innovation of lesson study with preservice mathematics teachers was highly successful, I plan on making a few minor changes for my next cycle of lesson study. First, I will make sure to set up my schedule beforehand with the field experience school and teacher. For this innovation I set up my schedule based on my university schedule first which forced me to make changes later due to scheduling conflicts with the field experience school. Second, I will have the preservice teachers take the efficacy survey not only as a pre-post survey, but also in the middle of the innovation before the first field experience teaching to give me a measure of their efficacy halfway through the innovation. Third, I will have each preservice teacher score themselves on the Lesson Study Planning and Instructional

Rubric and then meet with me to reflect on how their scores compare to mine. I believe that this will increase the self-reflection required in this innovation. I am excited to attempt a new cycle of lesson study with preservice teachers in the near future.

Benefits to me. I will continue to implement lesson study when I teach any methods course in the future. I am excited to start another cycle of this innovation next fall with some minor changes that were mentioned. I also plan to implement certain aspects of lesson study in all of my education courses I teach at my university. In fact, there is some research indicating that just using some aspects of lesson study such as collaborative planning, self-reflection, and debriefing for preservice teachers can be invaluable (Carrier, 2011). Further, I intend on implementing the concept of anticipating student misconceptions and how to deal with them in the lesson planning during my other preservice education courses. This will allow my preservice teachers to begin to shift their planning from a teacher-centered to more student-centered focus.

What is Next?

My goal is to implement lesson study with all the instructors in our college of education methods courses. I am planning a meeting with the dean of my college at the conclusion of this study to discuss it. I believe that the preservice teachers at our school will benefit greatly from this experience in more than one course.

I will also continue to do more cycles of lesson study and research in this area. I am considering going overseas for a semester to teach, and my hope is to be involved in a university that either uses lesson study or is willing to learn about it. I am excited to continue my growth with the incorporation of lesson study at my current position and possibly overseas.

Educational leadership. My growth as an educational leader was greatly enhanced from participating in this study. My major learning came from actually planning and implementing an innovation for an entire semester based on the current research in this field. I had never attempted such a bold new innovation for a class that I teach that was vastly different from my current practice. I have attempted short innovations in the past that were not based on research. This took a leap of faith on my part and one that I am glad now that I did. I know this has impacted my ability to be more open to similar innovations in the future. I also know that my confidence about planning and implementing an innovation similar to this has been increased due to the success of this project.

I believe much of the success from this innovation is based on the fact that my innovation was based on thorough research in the field of lesson study for preservice teachers as well as implementing a pilot study of the innovation. I set up my innovation based on what factors the research pointed out had been successful in the past. I refined my practice of using lesson study through my pilot study. I also made adjustments to fit my particular situation. I did find that the results of my study seemed to align very closely to most of the current research in the field.

Closing Thoughts

As I look back on this study as the culmination of my doctoral degree, I have many thoughts that come to mind. First, I am really proud of the fact that I was able to implement an innovation that made a positive impact on my preservice teachers. As I mentioned previously, this innovation in my math methods class were the most positive of any of the previous years I have taught this course.

Second, I know that my own practice as a methods instructor has been changed for the better. I am not satisfied with just having a successful innovation and then going back to my same old way of teaching this course. My hope is to become an expert in the field of lesson study for preservice teachers as I continue to do more action research cycles similar to this innovation.

Third, I learned that as an educator that we can always continue to try new things to improve our practice. I am not one to try new things often so I do appreciate that now my focus will be on studying the research before trying another innovation. I realized that through research, extensive detailed planning, and practicing, an innovation can be implemented successfully.

REFERENCES

Armor, D., Conroy-Osequera, P., Cox, M., King, N., McDonnell, L., Pascal, A., Pauley, E., & Zellman, G. (1976). *Analysis of the school preferred reading programs in selected Los Angeles minority schools* (R-2007-LAUSD). Santa Monica, CA: Rand Corp.

Ashton, P. T., (1985). Motivation and the teacher's sense of efficacy. In C. Ames & R. Ames (Eds.), *Research on motivation in education:* The classroom milieu (Vol. 2, pp. 141-174). Orlando, FL: Academic Press.

Ashton, P. T., & Webb, R. B. (1986). *Making a difference: Teachers' sense of efficacy and student achievement*. New York: Longman.

Ball, D. L. (2000). Bridging practices: Intertwining content and pedagogy in teaching and learning to teach. *Journal of Teacher Education, 51*(3), 241-247.

Ball, D., & Cohen, D. (1999). Developing practice, developing practitioners: Toward a practice-based theory of professional education. In L. Darlling-Hammond and G. Sykes (Eds.), *Teaching as the learning profession: Handbook of policy and practice*. San Francisco, CA: Jossey-Bass.

Ball, D. L., Hill, H. C., & Bass, H. (2005). Knowing mathematics for teaching: Who knows mathematics well enough to teach third grade, and how can we decide? *American Educator, 29*(1), 14-46.

Bandura, A. (1993). Perceived self-efficacy in cognitive development and functioning. *Educational Psychologist, 28*(2), 117-148.

Berliner, D. C. (1994). Expertise: The wonder of exemplary performance. In J. Mangieri & C. Block (Eds.), *Advanced educational psychology: Creating effective schools and powerful thinkers.* Niles, IL: Harcourt Brace Jovanovich.

Berman, P., McLaughlin, M., Bass, G., Pauly, E., & Zellman, G. (1977). *Federal programs supporting educational change: Vol. VII. Factors affecting implementation and continuation* (Rep. No. R-1589/7-HEW). Santa Monica, CA: RAND.

Blumer, H. (1969). *Symbolic interactionism.* Englewood Cliffs, NJ: Prentice Hall.

Bowman, C., & McCormick, S. (2000). Comparison of peer coaching versus traditional supervision effects. *Journal of Educational Research, 93*(4), 256-261.

Brookover, W. B., Schweitzer, J. J., Schneider, J. M., Beady, C. H., Flood, P. K., & Wisebaker, J. M. (1978). Elementary school social climate and school achievement. *American Educational Research Journal, 15*(2) 301-318.

Carrier, S. J. (2011). Implementing and integrating effective teaching strategies including features of lesson study in an elementary science methods course. *The Teacher Educator, 46*(2), 145-160.

Chassels, C., & Melville, W. (2009). Collaborative, reflective, and iterative Japanese lesson study in an initial teacher education program: Benefits and challenges. C*anadian Journal of Education, 32*(4), 734-763.

Chester, M., & Beaudin, B. (1996). Efficacy beliefs of newly hired teachers in urban schools. *American Educational Research Journal, 33*(1), 233-257.

Chokshi, S., & Fernandez, C. (2004). Challenges to importing Japanese lesson study: Concerns, misconceptions, and nuances. *Phi Delta Kappan, 85*(7), 520-525.

Christensen, L. B., & Johnson, B. (2008). *Educational research: Quantitative, qualitative, and mixed approaches* (3rd ed.). Thousand Oaks, CA: Sage Publishing, Inc.

Cohan, A., & Honigsfeld, A. (2006). Incorporating lesson study in teacher preparation. *The Educational Forum, 71*(1), 81-92.

Corbin. J., & Strauss, A. (2008). *Basics of Qualitative Research* (3rd ed.). Los Angeles, CA: Sage.

Creswell, J. W., & Clark, V. C. (2007). *Designing and conducting mixed-methods research*. Thousand Oaks, CA: Sage Publishing Inc.

Creswell, J. W. (2009). *Research design: Qualitative, quantitative, and mixed methods approaches*. Los Angeles, CA: Sage.

Cronbach, L.S. (1951). Coefficient alpha and the internal structure of tests. *Psychometrica, 16*, 297-334.

Curcio, F. R. (2002). *A user's guide to Japanese lesson study: Ideas for improving mathematics teaching.* Reston, VA: NCTM.

Czerniak, C. M. (1990, April). *A study of self-efficacy, anxiety, and science knowledge in preservice elementary teachers.* Paper presented at the annual meeting of the National Association for Research in Science Teaching, Atlanta, GA.

Darling-Hammond, L. (2006a). Constructing 21st century teacher education. *Journal of Teacher Education, 57*(3), 300-314.

Darling-Hammond, L. (2006b). *Powerful teacher education*. San Francisco, CA: Jossey-Bass.

Darling-Hammond, L., & Hammerness, K. (2005). The design of teacher education programs. In L. Darling-Hammond & J. Bransformd (Eds.), *Preparing teachers for a changing world: What teachers should learn and be able to do*. San Francisco, CA: Jossey-Bass.

Enochs, L. G., Smith, P. L., & Huinker, D. (2000). Establishing factorial validity of the mathematics teaching efficacy instrument. *School Science and Mathematics, 100*(4), 194-202.

Feiman-Nemser, S. (1983). Learning to teach. In L. Shulman, & G. Sykes (Eds.), *Handbook of teaching and policy*. New York, NY: Longman.

Fernandez, M. L. (2005). Exploring "lesson study" in teacher preparation. *Proceedings of the 29th Conference of the International Group for the Psychology of Mathematics Education, 2*, 305-312.

Fernandez, C., & Yoshida, M. (2004). *Lesson Study: A case of a Japanese approach to improving instruction through school-based teacher development.* Mahwah, NJ: Lawrence Erlbaum.

Gallucci, C., DeVoogt, M., Van Lare, I. H., Yoon, B., & Boatright, B. (2010). Instructional coaching: Building theory about the role and organizational support for professional learning. *American Educational Research Journal, 47*(4), 919-963. doi: 10.3102/0002831210371497

Ganesh, B., & Matteson, S. M. (2010). The benefits of reteaching lessons in preservice methods classes. *Action in Teacher Education, 32*(4), 52-60.

Gay, L.R., Mills, G.E., & Airasian, P. (2009). *Educational research: Competencies for analysis and applications*. New Jersey, NJ: Pearson.

Geist, E. (2000). Lessons from the TIMSS videotape study. *Teaching Children Mathematics*, 7, 180-185.

Glaser, B., & Strauss, A. (1967). *The discovery of grounded theory.* Chicago, IL: Aldine.

Goodell, J. E. (2006). Using critical incident reflections: A self-study as a mathematics teacher educator. *Journal of Mathematics Teacher Education, 9*(3), 221-248.

Graeber, A. O. (1999). Forms of knowing mathematics: What preservice teachers should learn. *Educational Studies in Mathematics Education, 38*(1-3), 189-208.

Greene, J. C. (2007). *Mixed methods in social inquiry*. San Francisco, CA: Jossey-Bass.

Grossman, P., Compton, C., Igra, D., Ronfeldt, M., Shahan, E., & Williamson, P. (2009). Teaching practice: A cross-professional perspective. *Teachers College Record, 111*(9), 2055-2100.

Groth, R. E. (2011). Improving teaching through lesson study. *Mathematics Teacher, 104*(6), 446-451.

Guskey, T. R. (1988). Teacher efficacy, self-concept, and attitudes toward the implementation of instructional innovation. *Teaching and Teacher Education, 4*(1), 63-69.

Guskey, T. R., & Passaro, P. D. (1994). Teacher efficacy: A study of construct dimensions. *American Educational Research Journal, 31*(3), 627-643.

Hartman, M. L. (2004). *Situating teacher learning in the practice of mathematics and science teaching*. (Unpublished doctoral dissertation). University of Michigan, Ann Arbor.

Haycock, K. (1998). *Good teaching matters: How well-qualified teachers can close the gap*. Washington, D.C: Education Trust.

Henningsen, M., & Stein, M., K. (1997). Mathematical tasks and student cognition: Classroom-based factors that support and inhibit high-level mathematical thinking and reasoning. *Journal for Research in Mathematics Education, 28*(5), 524-549.

Henson, R. K. (2001). The effects of participation in teacher research on teacher efficacy. *Teaching and Teacher Education, 17*(2), 819-836.

Hiebert, J., Morris, A., Berk, D., & Jansen, A. (2007). Preparing teachers to learn from teaching. *Journal of Teacher Education, 58*(1), 47-61.

Hiebert, J., & Stigler, J. (2000). A proposal for improving classroom teaching: Lessons from the TIMSS video study. *The Elementary School Journal, 101*(1), 3-20.

Hill, H. C., & Ball, D. L. (2004). Learning mathematics for teaching: Results from California's mathematics professional development institutes. *Journal for Research in Mathematics Education, 35*(5), 330-351.

Johnson, D. (2010). Learning to teach: The influence of a university-school partnership project on pre-service elementary teachers' efficacy for literacy instruction. *Reading Horizons, 50*(1), 23-48.

Kennedy, M. (1999). The role of preservice teacher education. In L. Darling-Hammond, & G. Sykes (Eds.), *Teaching as the learning profession: Handbook of policy and practice* (pp. 54-85). San Francisco, CA: Jossey-Bass.

Lampert, M., & Ball, D. (1999). Aligning teacher education with contemporary K – 12 reform visions. In L. Darling-Hammond & G. Sykes (Eds.), *Teaching as the learning profession* (pp. 33-53). San Francisco, CA: Jossey-Bass.

Lewis, C.C. (2002). *Lesson study: A handbook of teacher-led instructional change*. Philadelphia, PA: Research for Better Schools, Inc.

Lewis, C., & Tsuchida, I. (1998). A lesson is like a swiftly flowing river: How research lessons improve Japanese education. *American Educator, 22*(4), 12-17, 50-52.

Lewis, C., Perry, R., & Murata, A. (2006). How should research contribute to instructional improvement? The case of lesson study. *Educational Researcher, 35*(3), 3-14.

Loughran, J. J. (1996). *Developing reflective practice: Learning about teaching and learning through modeling.* London, England: The Falmer Press.

Ma, L. (1999). *Knowing and teaching elementary mathematics: Teacher's understanding of fundamental mathematics in China and the United States.* Mahwah, NJ: Lawrence Erlbaum Associates.

Maloch, B., Fine, J., & Flint, A. (2003). "I just feel like I'm ready": Exploring the influence of quality teacher preparation on beginning teachers. *The Reading Teacher, 56*(4), 348-350.

Marks, R. (1990). Pedagogical content knowledge: From a mathematical case to a modified conception. *Journal of Teacher Education, 41*(3), 3-11.

Mathews, M. E., Hlas, C. S., & Finken, T. M. (2009). Using lesson study and four-column lesson planning with preservice teachers. *Mathematics Teacher, 102*(7), 504-508.

McMahon, M. T., & Hines, E. (2008). Lesson study with preservice teachers. *Mathematics Teacher, 102*(3), 186-191.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis* (2nd ed.). Thousand Oaks, CA: Sage.

Mills, G. E. (2007). *Action Research: A guide for the teacher researcher* (3rd ed.). Upper Saddle River, NJ: Merrill.

Morris, A., Hiebert, J., & Spitzer, S. (2009). Mathematical knowledge for teaching in planning and evaluating instruction: What can preservice teachers learn? *Journal for Research in Mathematics Education, 40*(5), 491-529.

Munby, H., Russell, T., & Martin, A. K. (2001). Teachers' knowledge and how it develops. In V. Richardson (Ed), *Handbook of research on teaching* (4th ed.), (pp. 877-905). Washington D.C.: American Educational Research Association.

Office of Educational Research and Improvement (OERI). (1996). *Eighth-Grade Mathematics Lessons: United States, Japan, and Germany*. Washington , D.C.: U.S. Government Printing Office.

Post, G., & Varoz, S. (2008). Lesson-study groups with prospective and practicing teachers. *Teaching Children Mathematics,14*(8), 472-478.

Rosenholtz, S. (1989). *Teacher's workplace: The social organization of schools*. New York, NY: Longman.

Rivkin, S. G., Hanushek, E.A., & Kain, J.F. (2001). *Teachers, schools, and academic achievement.*
Cambridge, Mass.: National Bureau of Economic Research.

Sanders, W. L., & Horn, S. P. (1998). Research findings from the Tennessee value-added assessment system (TVAAS) database: Implications for educational evaluation and research. *Journal of Personnel in Education, 12*(3), 247-256.

Schon, D. A. (1987). *Educating the reflective practitioner*. San Francisco, CA: Jossey Bass.

Schon, D. A. (1983). *The reflective practitioner: How professionals think in action*. New York, NY: Basic Books.

Schunk, D., & Zimmerman, B. (1997). Social origins of self-regulatory competence. *Educational Psychologist, 32*(4), 195-208.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15*(2), 4-14.

Shulman, L. S. (2003, April). *From practice to theory and back again: Cases and portfolios as instruments of professional development*. Paper presented at the annual meeting of American Educational Research Association, Chicago.

Sibbald, T. (2009). The relationship between lesson study and self-efficacy. *School Science and Mathematics, 109*(8), 450-460.

Sims, L., & Walsh, D. (2008). Lesson study with preservice teachers: Lessons for lessons. *Teaching and Teacher Education, 25*(5), 724-733.

Stein, M. K., & Wang, M. C. (1988). Teacher development and school improvement: The process of teacher change. *Teaching and Teacher Education, 4*(2), 171-187.

Stewart, R., & Brendefur, J. (2005). Fusing lesson study and authentic achievement: A model for teacher collaboration. *Phi Delta Kappan, 86*(9), 681-687.

Stigler, J. W., & Hiebert, J. (1999). *The teaching gap: Best ideas from the world's teachers for improving education in the classroom*. New York, NY: Free Press.

Swackhamer, L. E., Koellner, K., Basile, C., & Kimbrough, D. (2009). Increasing the self-efficacy of inservice teachers through content knowledge. *Teacher Education Quarterly*, 36(2), 63-78.

Tabachnik, R., Popkewitz, T., & Zeichner, K. M. (1979-1980). Teacher education and the professional perspectives of student teachers. *Interchange, 10*(4), 12-29.

Takahashi, A., & Yoshida, M. (2004). Ideas for establishing lesson-study communities. *Teaching Children Mathematics, 10*(9), 436-443.

Tobin, K., Roth, W., & Zimmerman, A. (2001). Learning to teach science in urban schools. *Journal of Research in Science Teaching, 38*(8), 941-964.

Tolle, P. P. (2010). Lesson study: Still a work in progress in America. *Mathematics Teacher, 104*(3), 181-185.

Tschannen-Moran, M., & Woolfolk Hoy, A. (2007). The differential antecedents of self-efficacy beliefs of novice and experienced teachers. *Teaching and Teacher Education, 23*(6), 944-956.

Van Der Valk, T. A. E., & Broekman, H. H. G. B. (1999). The lesson preparation method: A way of investigating pre-service teachers' pedagogical content knowledge. *European Journal of Teacher Education, 22*(1), 11-22.

Wagner, L. R. (2003). *The best laid plans: Preservice teachers' use of lesson study as a model for attending to students' mathematical thinking*. (Unpublished doctoral dissertation). University of Wisconsin, Madison, WI.

Wang-Iverson, P., & Yoshida, M. (Eds.). (2005). *Building our understanding of lesson study*. Philadelphia, PA: Research for Better Schools.

Yoshida, M. (2008). Exploring ideas for a mathematics teacher educator's contribution to lesson study. In D. Tirosh & T. Wood (Eds.), *The international handbook of mathematics teacher education* (Vol. 2, pp. 85-106). Rotterdam, The Netherlands: Sense Publishers.

Zambo, R., & Zambo. D. (2008). The impact of professional development in mathematics on teacher's individual and collective efficacy: The stigma of underperforming. *Teacher Education Quarterly, 35*(1), 159-168.

APPENDIX A

LESSON STUDY DETAILED STEPS

Round 1 of Lesson Study

1. Preservice teachers were placed in lesson study teams of three based on their class schedules to align with school field experience teacher.

2. Lesson study teams chose one mathematics topic from a list of ten Algebra I topics. I provided ten mathematical topics that, based on my experience, are critical to teaching Algebra I and somewhat "difficult" to teach. Each lesson study team planned together in class and then sent the four-column lesson plan and math plan to me for revisions before the first teaching episode.

3. Each preservice teacher was included on all email correspondences between the lesson study team and me.

4. I provided specific feedback for both the four-column lesson plan and all the materials for the lesson after reviewing them. I returned them to the lesson study team for revisions each time they were revised.

5. One student from the lesson study team was chosen randomly to teach the lesson to the class. The lesson was video recorded in the back of the classroom with a flip camera. The class acted as "students" during the lesson. I took field notes in the back of the classroom.

6. The class participated in the debriefing session following the lesson. The preservice teacher who taught the lesson reflected first on their lesson and teaching, followed by their classmates and then myself. I acted as the facilitator during the debriefing sessions.

7. Following the debriefing session, I typically gave more feedback based on my field notes.

8. Each preservice teacher wrote weekly reflections about the process and their feelings. I typically provided a few prompts for them.

9. The lessons were revised and then re-taught by another preservice teacher from each lesson study team. Depending on the time, each lesson was taught twice or three times. The lessons for the field experience were taught three times.

10. The first version and final version of the lesson and teaching were used to score each lesson study team on the Lesson Study Planning and Instructional Rubric.

Intervention, Feedback, and Instruction #1

1. After lesson study Round 1 (this includes the teaching and re-teaching of the first lesson by each lesson study team), I taught a week of classes. During these classes I did some model teaching (I typically taught one of the lessons from the previous week that had already been taught and we discussed my strategies). I also taught math teaching strategies that I noticed were not strong based on the first round of lessons.

2. The preservice mathematics teachers reflected on this learning in their electronic journals after being given a prompt.

Round 2 of Lesson Study

1. This round was identical to Round 1 of lesson study in steps except that the lesson study teams chose a new lesson from my list that has not been taught already. The lesson study teams stayed the same throughout the entire process.

Intervention, Feedback, and Instruction #2

1. This week of instruction was cut short due to the schedule with the field experience classroom. We had to align our schedule to theirs for Round 3 and 4. Therefore, this week was made up after Round 3 of the lesson study.

Round 3 of Lesson Study

1. The field experience teacher chose appropriate lessons and dates for my preservice teachers to teach her classes. She chose two days of her class and sent me the topics. I gave those topics to each lesson study team and they began planning as before. I asked the field experience teacher for some feedback on how she taught certain topics in order to make sure that my lesson study teams were not going to teach something different than she would want in her classroom. I kept in constant communication with the field experience teacher throughout the planning process.

2. Each lesson study team sent me the four-column lesson plan and math lesson to revise as usual. They were then able to teach this lesson to our class. One team was able to teach it three times. They continued to revise this lesson after each preservice teacher taught in class.

3. Each lesson study team also went to observe the field experience teacher before going to teach in her classroom. They observed twice (one time the day before their lesson in order to know exactly how she taught a certain topic).

4. The field experience teacher had four sections of Algebra I so each lesson study member taught one lesson and they decided as a team who got to teach twice.

5. The lessons were video-recorded by the other team members.

6. The following week in class we participated in a debriefing session after observing the video recordings.

7. The weekly reflections continued throughout this process.

Intervention, Feedback, and Instruction #3

1. Due to the schedule of the field experience teacher's school, the regular schedule was adjusted so there were two weeks of instructional time before the fourth round. This made up for the time missed earlier and aligned us with the field experience classroom.

Round 4 of Lesson Study

1. This was identical to Round 3 of the lesson study process.

Intervention, Feedback, and Instruction #4

1. This instruction and feedback were based on the preservice teacher's final lesson in their field experience.

2. Each preservice teacher wrote their final reflections on the lesson study process.

3. Each preservice teacher was interviewed and did all the final surveys for the study.

APPENDIX B

LESSON STUDY PLANNING & INSTRUCTIONAL RUBRIC

Scoring Guide

Unsatisfactory (1 point)
The preservice teacher does not meet the expectations of the criteria at this stage in their placement.

Basic (2 points)
The preservice teacher minimally meets the expectations at this stage in their placement.

Proficient (3 points)
The preservice teacher meets and sometimes exceeds expectations at this stage in their placement.

Distinguished (4 points)
The preservice teacher consistently exceeds expectations at this stage in their placement.

Levels/Criteria	Comments	Score/Level
Planning for Instruction (Sequencing) The preservice teacher develops appropriate sequencing of learning experiences.		
Planning for Instruction (multiple representations) The preservice teacher provides multiple ways to demonstrate knowledge and skill.		
Planning for Instruction (student-centered) The preservice teacher creates developmentally appropriate instruction that takes into account individual learners' strengths, interests, and needs.		

Content Knowledge (Understanding of Content) The preservice teacher demonstrates a complete understanding of the content in lesson.		
Content Knowledge (Connects concepts) The preservice teacher links new concepts to familiar ones.		
Content Knowledge (Pedagogy: How to teach the math) The preservice teacher simplifies the mathematical concepts for the students.		
Content Knowledge (Resources & Technology) The preservice teacher uses supplementary resources and technology effectively to ensure accessibility and relevance for all learners.		
Content Knowledge (Appropriate Practice) The preservice teacher creates opportunities for students to learn and practice academic material in their content.		

Instructional Strategies (Student Engagement) The preservice teacher engages learners in using a range of engagement strategies to enhance the learning process.		
Instructional Strategies (Questioning Strategies) The preservice teacher uses effective questioning strategies that engage the learners in appropriate mathematical thinking.		

APPENDIX C

LESSON STUDY QUESTIONNAIRE

Strongly Agree (SA) Agree (A) Uncertain (UN) Disagree (D) Strongly Disagree (SD)

Directions: To what extent to you agree with the following statements?

Question	Strongly Agree (SA)	Agree (A)	Uncertain (UN)	Disagree (D)	Strongly Disagree (SD)
1. Planning in a group broadened my knowledge of how to teach mathematics more effectively.	SA	A	UN	D	SD

Comments:

_____

_____

_____

Question	Strongly Agree (SA)	Agree (A)	Uncertain (UN)	Disagree (D)	Strongly Disagree (SD)
2. Planning in a group broadened my knowledge of the mathematics.	SA	A	UN	D	SD

Comments:

_____

_____

_____

Question	Strongly Agree (SA)	Agree (A)	Uncertain (UN)	Disagree (D)	Strongly Disagree (SD)
3. Planning in a group helped me in planning my future lessons.	SA	A	UN	D	SD

Comments:

_____

_____

_____

Question	Strongly Agree (SA)	Agree (A)	Uncertain (UN)	Disagree (D)	Strongly Disagree (SD)
4. Planning in a group increased my confidence about my lessons.	SA	A	UN	D	SD

Comments:

_____

_____

_____

Question	Strongly Agree (SA)	Agree (A)	Uncertain (UN)	Disagree (D)	Strongly Disagree (SD)
5. Planning in a group increased my confidence when I had to teach.	SA	A	UN	D	SD

Comments:

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_____

Question	Strongly Agree (SA)	Agree (A)	Uncertain (UN)	Disagree (D)	Strongly Disagree (SD)
6. The debriefing sessions were helpful in analyzing my lessons.	SA	A	UN	D	SD

Comments:

_____
_____
_____

Question	Strongly Agree (SA)	Agree (A)	Uncertain (UN)	Disagree (D)	Strongly Disagree (SD)
7. Analyzing each other's lessons during the debriefing helped me learn to assess lessons more effectively.	SA	A	UN	D	SD

Comments:

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_____
_____

Question	Strongly Agree (SA)	Agree (A)	Uncertain (UN)	Disagree (D)	Strongly Disagree (SD)
8. The feedback I received during the debriefing sessions from my peers was helpful to my planning.	SA	A	UN	D	SD

Comments:

_____
_____
_____

Question	Strongly Agree (SA)	Agree (A)	Uncertain (UN)	Disagree (D)	Strongly Disagree (SD)
9. My confidence in my planning increased because of the debriefing sessions.	SA	A	UN	D	SD

Comments:

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Question	Strongly Agree (SA)	Agree (A)	Uncertain (UN)	Disagree (D)	Strongly Disagree (SD)
10. The feedback I received during the debriefing sessions from my instructor was helpful to my planning.	SA	A	UN	D	SD

Comments:

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_____
_____

Question	Strongly Agree (SA)	Agree (A)	Uncertain (UN)	Disagree (D)	Strongly Disagree (SD)
11. Revising our lessons after receiving feedback from the instructor helped me to plan more effectively.	SA	A	UN	D	SD

Comments:

_____
_____
_____

Question	Strongly Agree (SA)	Agree (A)	Uncertain (UN)	Disagree (D)	Strongly Disagree (SD)
12. Revising lessons after teaching helped me to plan more effectively for the re-teaching. .	SA	A	UN	D	SD

Comments:

_____

_____

_____

Question	Strongly Agree (SA)	Agree (A)	Uncertain (UN)	Disagree (D)	Strongly Disagree (SD)
13. Revising our lessons after receiving feedback from my peers helped me to plan more effectively.	SA	A	UN	D	SD

Comments:

_____

_____

_____

Question	Strongly Agree (SA)	Agree (A)	Uncertain (UN)	Disagree (D)	Strongly Disagree (SD)
14. My confidence in my planning increased due to being able to revise my lessons.	SA	A	UN	D	SD

Comments:

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Question	Strongly Agree (SA)	Agree (A)	Uncertain (UN)	Disagree (D)	Strongly Disagree (SD)
15. I felt more confident teaching in my field experience because my lesson had been revised.	SA	A	UN	D	SD

Comments:

_____

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APPENDIX D

MATHEMATICS TEACHING EFFICACY BELIEFS INSTRUMENT

Please indicate the degree to which you agree or disagree with each statement below by circling the appropriate letters to the right of each statement.

SA	A	UN	D	SD
Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree

1.	When a student does better than usual in mathematics, it is often because the teacher exerted a little extra effort.	SA	A	UN	D	SD
2.	I will continually find better ways to teach mathematics.	SA	A	UN	D	SD
3.	Even if I try very hard, I will not teach mathematics as well as most new math teachers.	SA	A	UN	D	SD
4.	When the mathematics grades of students improve, it is often due to their teacher having found a more effective teaching approach.	SA	A	UN	D	SD
5.	I know how to teach mathematics concepts effectively.	SD	A	UN	D	SD
6.	I will not be very effective in monitoring mathematics activities.	SA	A	UN	D	SD
7.	If students are underachieving in mathematics, it is most likely due to ineffective mathematics teaching.	SA	A	UN	D	SD
8.	I will generally teach mathematics ineffectively.	SA	A	UN	D	SD
9.	The inadequacy of a student's mathematics background can be overcome by good teaching.	SA	A	UN	D	SD
10.	When a low-achieving child progresses in mathematics, it is usually due to extra attention given by the teacher.	SA	A	UN	D	SD
11.	I understand mathematical concepts well enough to be effective in teaching secondary mathematics.	SA	A	UN	D	SD
12.	The teacher is generally responsible for the achievement of students in mathematics.	SA	A	UN	D	SD
13.	Students' achievement in mathematics is directly related to their teacher's effectiveness in mathematics teaching.	SA	A	UN	D	SD
14.	If parents comment that their child is showing more interest in mathematics at school, it is probably due to the performance of the child's teacher.	SA	A	UN	D	SD

15.	I will find it difficult to use manipulatives to explain to students why mathematics works.	SA A UN D SA
16.	I will typically be able to answer students' questions.	SA A UN D SA
17.	I wonder if I will have the necessary skills to teach mathematics.	SA A UN D SD
18.	Given a choice, I will not invite the principal to evaluate my mathematics teaching.	SA A UN D SD
19.	When a student is having difficulty understanding a mathematical concept, I will usually be at a loss as to how to help the student understand it better.	SA A UN D SD
20.	When teaching mathematics, I will usually welcome student questions.	SA A UN D SD
21.	I do not know what to do to turn my students on to mathematics.	SA A UN D SD

APPENDIX E

LESSON STUDY FINAL INTERVIEW QUESTIONS

1. What were the main benefits of the lesson study process for you? Explain.
2. What are some ways this process could be improved in the future? Why?
3. Did lesson study impact your planning of math lessons? Explain.
4. Did lesson study impact your instructional ability (mathematical teaching)? Explain.
5. Did lesson study impact your math teaching efficacy (belief in your ability to effectively teach math)? Explain.
6. Which aspects of lesson study were most beneficial to you? (i.e. collaborative planning, revisions, debriefing, re-teaching,..)?
7. Any other comments you would like to add about the lesson study process?

APPENDIX F

SAMPLE ALGEBRA I LESSONS

1. Real Number System
2. Exponent Rules
3. Solving Inequalities (Flip the sign)
4. Equations (solve one-step equations or solve with variables on both sides)
5. Negative and Zero Exponents
6. Factoring Trinomials
7. Simplifying Like Terms (positive numbers only)
8. Graphing a line using slope-intercept form
9. Solving Systems of Equations (By graphing, substitution, or elimination)
10. Quadratic Formula

APPENDIX G

DEBRIEFING SESSION GROUND RULES

Adapted from Sims & Walsh (2008)

1. The focus of the debriefing session must be on the teaching (not the teacher).

2. Each member of the lesson study team will refer to the lesson as “our” throughout the debriefing session.

3. All comments made about the lesson should focus on the goal (objective) of the lesson and what was observed during the teaching.

APPENDIX H

INSTITUTIONAL REVIEW BOARD APPROVAL - ASU

ASU Knowledge Enterprise Development

Office of Research Integrity and Assurance

To:	Ronald Zambo FAB
From:	for Mark Roosa, Chair Soc Beh IRB
Date:	04/26/2012
Committee Action:	**Exemption Granted**
IRB Action Date:	04/26/2012
IRB Protocol #:	1204007738
Study Title:	Using Lesson Study with Preservice Secondary Mathematics Teachers: Effects on Instruction, Planning, and Efficacy to Teach

The above-referenced protocol is considered exempt after review by the Institutional Review Board pursuant to Federal regulations, 45 CFR Part 46.101(b)(1) .

This part of the federal regulations requires that the information be recorded by investigators in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects. It is necessary that the information obtained not be such that if disclosed outside the research, it could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.

You should retain a copy of this letter for your records.

APPENDIX I

INSTITUTIONAL REVIEW BOARD APPROVAL - GCU

GRAND CANYON UNIVERSITY™

3300 West Camelback Road, Phoenix Arizona 85017 602.639.7500 Toll Free 800.800.9776 www.gcu.edu

DATE:	May 16, 2012
TO:	Jameel Mostofo, M.A.
FROM:	Grand Canyon University Institutional Review Board
STUDY TITLE:	[329455-1] Using Lesson Study with Preservice Secondary Mathematics Teachers: Effects on Instruction, Planning, and Efficacy to Teach Mathematics
IRB REFERENCE #:	329455-1
SUBMISSION TYPE:	New Project
ACTION:	APPROVED
APPROVAL DATE:	5/16/2012
EXPIRATION DATE:	5/15/2012
REVIEW TYPE:	
REVIEW CATEGORY:	Expedited review category # 7.7

Thank you for your submission of New Project materials for this research study. Grand Canyon University Institutional Review Board has APPROVED your submission. This approval is based on an appropriate risk/benefit ratio and a study design wherein the risks have been minimized. All research must be conducted in accordance with this approved submission.

This submission has received expedited review based on the applicable federal regulation.

Please remember that informed consent is a process beginning with a description of the study and insurance of participant understanding followed by a signed consent form. Informed consent must continue throughout the study via a dialogue between the researcher and research participant. Federal regulations require each participant receive a copy of the signed consent document.

Please note that any revision to previously approved materials must be approved by this office prior to initiation. Please use the appropriate revision forms for this procedure.

All SERIOUS and UNEXPECTED adverse events must be reported to this office. Please use the appropriate adverse event forms for this procedure. All FDA and sponsor reporting requirements should also be followed.

Please report all NON-COMPLIANCE issues or COMPLAINTS regarding this study to this office.

Please note that all research records must be retained for a minimum of three years.

Based on the risks, this project requires Continuing Review by this office on an annual basis. Please use the appropriate renewal forms for this procedure.

If you have any questions, please contact Cynthia Bainbridge at 602-639-6884 or cbainbridge@gcu.edu. Please include your study title and reference number in all correspondence with this office.